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A 1,000-HP. DIRECT-CONNECTED GAS ENGINE and gas compressor has been used to pump natural gas at a station three miles from Lancaster, O., since January, 1901. The engine was built by the Snow Steam Pump Works, at Buffalo, N. Y., after designs by Mr. J. S. Klein, M. Am. Soc. M. E., Superintendent of the Department of Machinery, National Transit Co., Oil City, Pa. It is of the flywheel, horizontal type, with four 25 × 48-in. cylinders. The gas compressors are 16 × 24 ins., with 8-in. inlet and outlet connections, the outlet pipes being laid in a creek for 400 ft. from the compressors, to cool the gas before it enters the main line. The pump is guaranteed to run at 120 revs. per min., and to deliver 12,000,000 cu. ft. of gas each 24 hours, raising the gas from 100 lbs. to 315 lbs. pressure. This is the second engine of the sort built after designs by Mr. Klein. Some further details of the engine and pumping station are given in a paper on the subject read before the Ohio Gas Light Association by Mr. E. E. Eysenbach, of Columbus, O., and printed in a recent number of the American Gas Light Journal.

A STEAM ENGINE AND MINING MACHINERY COMbination is being perfected in Milwaukee, among prominent manufacturers in these lines, though two separate organizations may be made. According to press accounts, the American Steam Engine Co. would be capitalized for $30,000,000, and "possibly" combine the following companies: The Corliss Steam Engine Works, of Providence, R. I.; the American Wheelock Engine Co., of Worcester, Mass.; Hamilton Corliss Steam Engine Co., Hamilton, O.; Southwark Foundry & Machine Co., of Philadelphia; Lane & Bodley Co., of Cincinnati; Rice & Sargent, of Providence, R. I.; Robert Wetherill, of Chester, Pa.; Cooper-Corliss Co., of Mount Vernon, O., and the Vieter Mfg. Co., of Milwaukee. The mining machinery combination may includ: The Pennsylvania Iron Works; the E. P. Allis Co., of Milwaukee; Fraser & Chalmers, of Chicago, and the Dixon Mfg. Co., of Scranton, Pa. The Pennsylvania Iron Works, controlled by Elkins, Widener and Dolan, of Philadelphia, seems to be back of both consolidations.

A CIVIL SERVICE EXAMINATION for the position of draftsman, bridge construction, will be held on Friday, May 17, in the office of the Municipal Civil Service Commission, 346 Broadway, New York. The subjects of the examination will be technical knowledge, experience, handwriting, mathematics. The technical paper will be mainly devoted to structural bridge work and designing. Candidates should provide their own drawing boards and instruments. Applications may be obtained from Lee Phillips, Secretary, and for further information with reference to the examination apply to F. G. Ireland, Chief Examiner, Municipal Civil Service Commission, New York city.

THE CARNEGIE RESEARCH SCHOLARSHIP has been recently founded by Mr. Andrew Carnegie in connection with the British Iron and Steel Institute, and backed by a deposit of $32,000 in bonds placed with the Council of the Institute. Candidates must be under 35 years of age; and the purpose of this bequest is to enable students, who have passed through college or have been trained in some industrial establishment, to conduct original research in the metallurgy of iron and steel and allied subjects. There is no restriction as to place where this research is to be made, other than that the place shall be properly equipped for the investigation proposed. The appointment to a scholarship is for one year; but the Council, at its discretion, may renew the scholarship for a further period, instead of electing a new scholar. The results of any such research are to be reported to the Institute in the form of a paper presented at its annual general meeting. And in case of special merit the Andrew Carnegie Gold Medal shall be awarded to the author.

THE MASSACHUSETTS TOPOGRAPHICAL SURVEY Commission reports, for 1900, that it has published 41 out of the 353 town boundary atlases required for the state. As fast as printed these atlases are distributed as follows: Two copies for the use of the city or town officers, one copy to each public library in the city or town, one copy each to the State Library, to the Commissioner of Public Records, to the Boston Public Library, and to the U. S. Geological Survey; 10 copies are distributed by the Topographical Survey. The remaining copies are sold to the public at $2.50 each, in paper covers—practically the cost of printing. A new map of the Metropolitan District of Boston is nearly completed, and the U. S. Geological Survey expects shortly to issue photo-lithographic copies on a scale of 1-20,000, with 20 ft. contour intervals. Since its organization in 1884 the commission has expended $256,372 on the topographical map of Massachusetts on the locating and remarking of the state boundary lines.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Plymouth branch of the Philadelphia & Reading Ry. at Corson, Pa., on April 20. A coal train became stalled on a grade and the locomotive was sent ahead to telegraph for assistance. On the way it collided with a local passenger train. One person was killed and two were seriously injured.

A DERRICK CAR and gondola toppled from a bridge over Eighteen Mile Creek at Idlewood, N. Y., on April 16. The bridge was recently built by the King Bridge Co. and is used by both the Pennsylvania and the New York, Chicago & St. Louis railways. Some employes of the latter road were engaged in removing some large rocks which had been used in the abutments of the old bridge to the gondola car. When lifting a rock heavier than usual the clamp holding the derrick car to the bridge gave way and both cars were precipitated to the bottom of the ravine 80 ft. below. Two men were killed and a number seriously injured.

HEAVY FLOODS have destroyed much property along the Ohio River during the past week. The lower quarters of the cities of Allegheny and Pittsburg were deeply submerged for several days and the damage in that neighborhood is reported to be between two and three million dollars. The high-water stage is now passing down the river and much damage will, it is expected, be done at Cincinnati and other points.

FIREPROOF GRAIN ELEVATORS may be loaned money by banks without insurance to cover the amount of the loan as the result of a law enacted by the Minnesota State Legislature at its last session. The old law prevented banks from loaning money upon grain even in steel, tile or other fireproof elevators unless insurance was carried; the new law makes exception of elevators pronounced by the State Railway Commission to be fireproof.

THE BOLOMETER, invented by Prof. S. P. Langley and described by him at a late meeting of the National Academy of Sciences, at Washington, D. C., is an instrument for the measurement of heat wave-lengths and it indicates heat to the one-thousand-millionth of a degree Centigrade. By the use of this instrument the Newtonian spectrum has been increased twenty times in length; and studies are being made that may yet disclose secrets having an intimate relation to the sun's seasonable changes, and their effect in stimulating or diminishing the productive energy of the earth. Prof. Langley believes that through these observations we may yet discover how the sun maintains all life on this planet, a problem yet unsolved.

THE BOSTON UNIVERSAL PANTOGRAPH, now on the market, differs from the ordinary instrument of this type in having the pivotal point mounted on an 18-in. celluloid triangle, which is secured in position by weights only. The advantages of this device are evident. The pantograph can be removed from a drawing entirely and replaced as often as desired; the position of the triangle can be changed, with the same pivotal point retained, and access be thus gained to all parts of the drawing; and by ruling the drawing the pivotal point can be systematically moved from place to place, and plans of unlimited size can thus be enlarged or reduced. It is also applicable to other uses, more fully described by its maker, Mr. G. G. Ledder, 302 Washington St., Boston, Mass.

FREIGHT RULES FOR SHIPPING TRANSITS, ETC., are not understood by the majority of engineers. The express companies' classification rules contain special clauses regulating the shipping of engineering instruments, which read as follows: Surveyors' instruments, enclosed only in their own box or case, agents will charge three times merchandise rates. Surveyors' instruments, enclosed in their own box or case, and again covered in an additional box, agents will charge one merchandise rate. This fact is brought to our attention by Messrs. Heller & Brightly, instrument makers, of Philadelphia, who note having received lately in one day two injured transits from Indianapolis, Ind. The weight was the same in both cases, but one was in its regular case only, and the other was similarly cased and then boxed in addition. The freight charge on the first was $2.70; on the other 90 cts. Both charges were correct and in exact accordance with the rules quoted above.

A TEN-WHEEL FREIGHT LOCOMOTIVE of unusual size has recently been built at the shops of the Great Western Ry., England, and is almost as extraordinarily ugly and disproportioned (in appearance at least) as it is possible to imagine. All ideas of symmetry appear to have been purposely neglected. The driving wheels are only 4 ft. 8 ins. diameter, and are almost concealed, being placed inside deep plate frames which reach above the tops of the wheels. Above the frames are groups of coiled springs seated on stems which rest upon the driving axle boxes. The front end is carried by a four-wheel truck having 34-in. wheels, and the cylinders, 19 × 26 ins., are under the smokebox. The boiler is set high above the wheels and frames, and has a huge Belpaire firebox which reaches to the top of the cab. The smokebox has an extension front, with a saddle extending out to the frames for the full length of the smokebox. The short, stumpy smokestack resembles an inverted silk hat, and the sandbox is peculiar in being saddle shaped, extending downwards on each side of the boiler. There is no steam dome, but a safety valve and whistle mounting at the rear end of the boiler barrel. The six-wheel tender has a shallow tank carrying only 2,500 gallons of water, and its coal space is surrounded by a railing. Mr. Wm. Dean is Superintendent of Motive Power.

TESTS OF THE CORRUGATED FIREBOX LOCOMOtive, invented by Mr. Cornelius Vanderbilt, were made on the New York Central & Hudson River R. R. some time ago and showed a fuel economy of about 10% over a similar locomotive with the ordinary firebox. The reasons for the better economy of the corrugated firebox were stated as follows by Mr. S. M. Vauclain, of the Baldwin Locomotive Works, in a recent address before the New England Railroad Club:

> Internal examination of one of these boilers developed the fact that no scale of any account had accumulated on the crown sheet or on the side sheets. Of course, it is plain that where the crown leaves off the side sheets begin, but there was no scale at all on the upper surface of the firebox, whereas on the crown sheets of the other locomotives a very thick scale had formed; sediment had settled and had not been washed off. The firebox of the ordinary engine was but 42 ins. wide, and was full length, I think 10 ft., in round figures, whereas in the firebox of the Vanderbilt boiler the grate was about 54 ins. wide and not so long. The fire doors were rather high, so that a man had no difficulty in looking at his fire and seeing that the fuel was properly distributed. A portion of the economy, therefore, is attributed to the absence of scale in the firebox and a portion to the fact that the grate surface was nearer square and enabled the man to distribute his fuel to better advantage, and also prevented the fireman from carrying too heavy a fire; whereas in the other engines he can carry the fire as he pleases, and we all know that where it is possible to carry a light fire and have a free circulation of air through the grates, getting the proper amount admitted, and admitted at the right time and in the right place, the combustion is far superior to what it is where we have a firebox that is choked with fuel too deep and too thick and improperly distributed.

The Vanderbilt locomotive was illustrated and described in our volume July-Dec., 1899, p. 123.

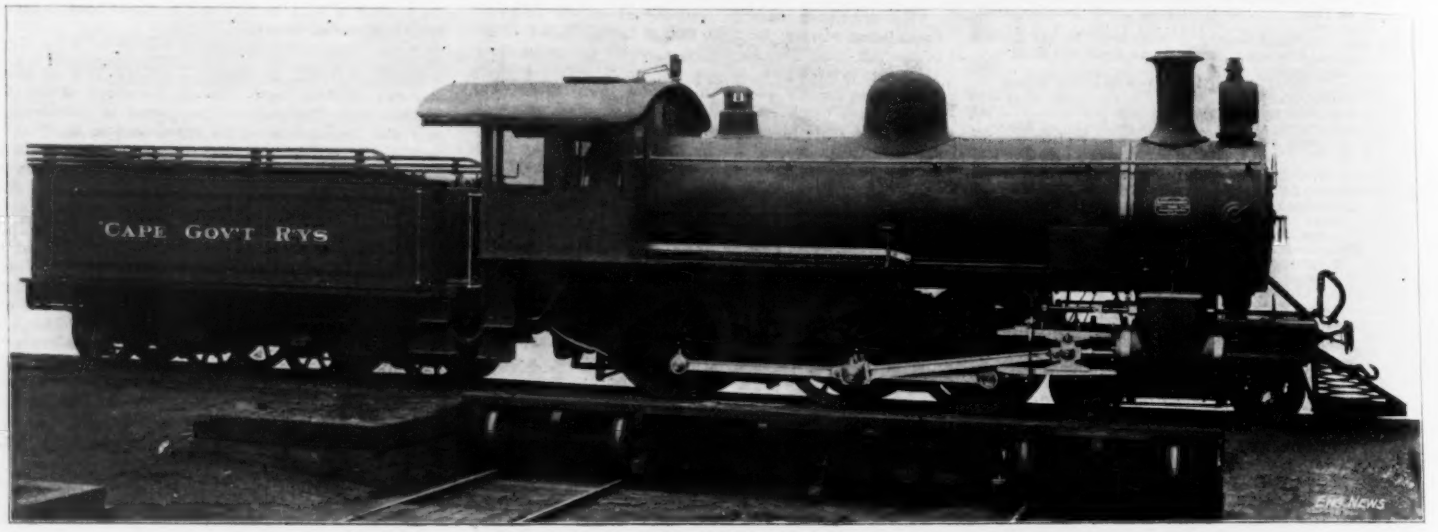
THE INTERNATIONAL ASSOCIATION FOR TESTING Materials will hold its next Congress at Buda-Pest, on Sept. 9-14, 1901. A series of technical papers will be presented and the reports of the chairman of technical committees will be received, in connection with the regular business of the association. Prof. L. von Tetmajer, of Zurich, is President.

THE ARTIFICIAL PRODUCTION OF GRAPHITE is discussed in an article by Clinton P. Townsend in the "Electrical World and Engineer" for April 6. He reviews the experiments made and results obtained up to the present time and arrives at the following conclusions:

> The essential condition for the formation of graphite may be considered to be the presence of carbon in the ionized state and its deposition therefrom. This, so far as we know, may be accomplished by any one of four methods:
>
> (1) By solution in metals or carbids.
> (2) By the direct conveying action of the electric discharge, and notably the arc, upon carbon.
> (3) By the action of the electric discharge upon gaseous carbon compounds.
> (4) By the disassociation by heat of certain carbon compounds, notably the carbids.
>
> These four general methods embrace all experiments which have been made.

AMERICAN LOCOMOTIVES FOR SOUTH AFRICA.

Among the locomotives recently built in this country for foreign railways are a number for the Cape Government Railways, of Cape Colony, South Africa. The standard gage of these railways is 3 ft. 6 ins., and the fuel for the locomotives is bituminous coal. The accompanying cut illustrates one of the ten-wheel passenger engines, which is thoroughly American in general design, although a number of special features have been introduced to meet the requirements of the railway authorities. The radial-stayed firebox is of copper plates,



TEN-WHEEL PASSENGER LOCOMOTIVE; CAPE GOVERNMENT RAILWAYS (SOUTH AFRICA).
Schenectady Locomotive Works, Builders.

and has a firebrick arch supported on angle irons. The foreign equipment includes the Gresham & Craven injectors and sanding gear, a 3-in. Ramsbottom safety valve, and link-and-pin couplers of a type very generally used in colonial service. The engine is fitted with a steam brake on two pairs of driving wheels, and the automatic vacuum brake on tender and for train. The boiler has an extension smokebox, and the sandboxes are placed at the ends of the running boards.

These engines, as well as some consolidation freight engines of very similar design, were built by the Schenectady Locomotive Works, of Schenectady, N. Y., and we are indebted to the builders for photographs and other information. The general dimensions of the ten-wheel and consolidation engines are given below in our standard form:

American Locomotives for the Cape Government Railways (South Africa).

Items.	Engines—Ten-wheel.	Consolidation.
Driving wheels	(6) 4 ft. 6 ins.	(8) 4 ft. 0 ins.
Truck wheels	(4) 2 " 4½"	(2) 2 " 4½"
Tender wheels	(8) 2 " 9⅛"	(8) 2 " 9½"
Wheelbase, driving	11 " 4 "	14 " 6 "
Engine.	21 " 2 "	21 " 8 "
Engine and tender	44 " 11¾"	46 " 0 "
Weight, on drivers	85,350 lbs.	101,670 lbs.
Total engine	107,830 "	115,450 "
Tender, empty	35,020 "	36,020 "
Cylinders	17½ x 26 ins.	18½ x 24 ins.
Steam ports	1¾ x 16 "	1¾ x 16 "
Exhaust ports	2½ x 16 "	2½ x 16 "
Bridges	1 in.	1 in.
Slide valves	Richardson balanced.	Richardson balanced.
Maximum travel	5 ins.	5 ins.
Outside lap	1 in.	1 in.
Inside lap	None.	None.
Lead	None.	None.
Boiler, diameter	5 ft. ¼-in.	5 ft. ¼-in.
Working pressure	180 lbs.	180 lbs.
Firebox (copper) length.	7 ft. 11 ins.	8 ft. 5 ins.
Width	2 " 4½"	2 " 4½"
Depth, front	5 " 2½"	5 " 5½"
Depth, back	4 " 0½"	4 " 5¼"
Radial stays, diameter	1 in.	1 in.
Tubes (charcoal iron) No.	195	196
Diameter	2 ins.	2 ins.
Length	11 ft. 6⅝ ins.	12 ft. 7⅝ ins.
Heating surface, tubes.	1,163.53 sq. ft.	1,280.7 sq. ft.
Firebox	111.70 "	126.6 "
Total	1,275.23 "	1,407.3 "
Grate area	18.84 "	20.02 "
Exhaust pipes	Single.	Single.
Nozzles, diameter	4¾, 5, 5½ ins.	4½, 4½, 4¾ ins.
Smokestack, diameter	16 and 14 ins.	16 and 14 ins.
Rail to top	12 ft. 8 ins.	12 ft. 10 ins.
Capacity: Tender tank.	3,300 gallons.	3,600 gallons.
Coal space	6 tons.	6½ tons.

SEPTIC TANKS, PUMP WELLS AND FILTER BEDS OF THE DRAPER CO., HOPEDALE, MASS.

By Leonard Metcalf, Assoc. M. Am. Soc. C. E.*

In the summer of 1894 a sewerage system, designed by Mr. W. E. Wheelock, Jr., with Mr. Samuel M. Gray, M. Am. Soc. C. E., as consulting engineer, was built in the town of Hopedale, Mass., to dispose of the sewage from the Draper Co.'s mills, then employing about 800 operatives, as well as of the sewage, estimated at 20,000 gallons per 24 hours, from some forty house connections in that town. The company is engaged in the manufacture of cotton machinery.

The sewers, which ranged from 6 to 10 ins. in diameter, discharged into two tight brick sedimentation tanks, each 20 × 10 ft. × 4.4 ft. deep (with semicircular ends) of 11,750 gallons joint capacity, giving upwards of five hours' sedimentation and septic action. From these tanks the effluent ran into the Mill River, a small stream tributary to the Blackstone River.

Development in the company's business, and the consequent large increase in the number of operatives employed in the mills, resulted in the

Fig. 2. View of Septic Tanks and Pump Wells at Hopedale, Mass., Ready for Roof.
(Looking Towards Inlet End.)

outgrowth of the sewage disposal plant. In the summer of 1899 the writer was retained to investigate and report to the company upon the best method of meeting the new conditions. Later on the works described below were designed by him and built under his supervision.

The acid wastes from the pickling plant of the foundry were also a source of trouble, owing to the relatively small dry-weather flow of the stream, and the consequent action of the acid upon the sewage effluent discharged into the river. The presence of the acid wastes in the water resulted in the precipitation of the fatty acids from soap solutions and the formation of iron oxide on the stones and grass in the river. The separation of these wastes from the sewage was therefore recommended, with the construction of a lime precipitating plant and cinder filter-beds for treating and clearing the wash water of the acid pickling plant before discharging it into the river. The latter plant was designed by Mr. Robert Spurr Weston, consulting chemist and bacteriologist, of Boston, and has been constructed recently.

Weir gagings were made Aug. 25-28, 1899, to determine the mean daily flow of sewage from the mills—then employing about 1,600 operatives—and from the 106 house connections tributary to the system. The daily discharge was found to be about 110,000 gallons, 65,000 gallons flowing between the hours of 7 a. m. and 6 p. m. and 45,000 gallons by night. The Sunday flow was approximately two-thirds of this amount. A little later in the fall the discharge, with 2,000 operatives, was estimated at 127,000 gallons per 24 hours.*

The new sewage disposal works were designed for a future discharge of 300,000 gallons per day, though such portions of the plant as could readily be extended at any time were built to meet present requirements only.

Owing to the proximity of the mill and the short and steep grades of the sewer pipes in the town, the sewage reached the settling tanks when very fresh, probably within fifteen minutes after its entrance into the system. Pumping was necessary, and suitable filtration lands were limited in area and of rather fine material. The use of sedimentation or septic tanks and sand filtration beds was therefore decided upon, the sedimentation or macerating tanks to be combined with storage or pump wells in such manner as to give flexibility to the system, by which the period of sedimentation could be varied and Sunday pumping dispensed with.

The general arrangement and design of tanks is shown by the plan and sections, Fig. 1, and the view, Fig. 2. There are two sedimentation tanks side by side, each 40¾ ft. long by 12½ ft. span and 11½ ft. deep at the level of the springing line, giving a joint capacity of 70,700 gallons and a period of sedimentation of approximately ten hours, based upon the present discharge of 175,000 gallons per 24 hours; or a linear velocity of 4 ft. per hour through the tanks.

At the end, and in continuation of, the sedimentation tanks are two storage or pump wells of like dimensions, save as to their length, which is 2 ft.

*14 Beacon St., Boston, Mass.

*Oct. 31, 1900, with 2,700 operatives and 150 house connections, the discharge was gaged again and found to be 170,000 gallons per 24 hours.

greater—of a joint storage capacity of 74,200 gallons.

The tanks are built of Portland cement concrete, mixed in the proportion of 1:3:5½ in the walls, and 1:2½:4½ in the roof. (These quantities are based upon the total amount used.) Shear gates are provided, by the manipulation of which any chamber may be cut off and drained of its contents by the centrifugal pump, without disturbing the other chambers.

The sedimentation tanks themselves may also be utilized in whole or in part as pump wells by opening the 8-in. gates under the hoods, or the 10-in. gates at the bottom. Ordinarily these gates are closed during the week and the effluent from the sedimentation tanks is decanted from a point about 18 ins. below the surface into the storage wells. From these it is pumped in the early morning and again in the late afternoon, so that the full storage, 74,000 gallons, is available for the night flow. In case of emergency this storage is further increased by the backing up of the sewage in the pipes and the tanks until an additional foot in depth has been stored, when the sewage begins to overflow into the river.

On Saturday afternoons the 8-in. gates under the hoods are opened and the sewage in the sedimentation tanks is drained simultaneously for a depth of 8½ ft., leaving about 2 ft. of sludge, liquid and blanket in the chambers, as the storage wells are pumped dry, after which the 8-in. gates are again closed. A storage of about 135,600 gallons to the inlet invert, or 152,500 gallons to the 12-in. overflow invert, is thus obtained, in which to store the Sunday flow until Monday morning. Inspection manholes are provided at each end of the chambers.

A 15-in. weighted copper float, with chain running over brass pulleys and soft drawn copper wire running through a 1-in. wrought iron pipe to the pump well in the mill, indicates by an index upon a gage rod the level of the liquid in the storage chambers.

Provision has been made for the future extension of the plant by the construction of one or more additional units beside the two present ones.

From the storage wells the effluent is pumped onto sand filter beds by a 6 × 6-in. centrifugal Class A pump, made by the Lawrence Machine Co., which drafts through 188 ft. of 10-in. cast-iron pipe and discharges into the 10-in. cast-iron force main. The pump is belted to run at a rate of approximately 310 revs. per min., discharging 700 gallons per min. against a mean static head of 25 ft. (including the suction lift, which varies from 2½ to 14 ft.). The 10-in. cast-iron force main, which is 3,263 ft. long, is laid on flat grades, with a slight summit at the pump and a sharp one at the filter beds. On the discharge end of the pump is a 10-in. gate and a 2-in. air vent pipe, which is carried out of doors in the second story of the building, and which is always open, while on the suction side there is a 10-in. check valve accessible from the pump well.

The sand filtration area consists of four filter beds and one small sludge bed, all graded in place, of the following sizes:

Bed.	Feet.	Acre.	Bed.	Feet.	Acre.
No. 1	110.0 × 300	0.757	No. 4	181.5 × 121	0.504
No. 2	181.0 × 140	0.578	Sludge	120.0 × 25	0.069
No. 3	181.5 × 120	0.5			

Beds Nos. 1 and 2 are of reasonably coarse material, with an effective size of sand of approximately 0.25 mm., but contain some ledge and many boulders. Although it was not originally intended to underdrain these two beds, as it was thought that the character of the material and the rapid slope of the ground in all directions away from the beds might make this unnecessary, it has since been found advisable, and underdrains have therefore been laid.

Beds Nos. 3 and 4 are much more homogeneous, though of finer sand, with an effective size 0.15 mm. They are underdrained with two lines of 4-in. vitrified sewer pipe 60 ft. apart in each bed. The beds are used in rotation, each bed being dosed once in two days, thus giving an average rate of filtration of approximately 75,000 gallons per acre per 24 hours. The sewage is distributed on the beds by wooden trough carriers, similar to those in use for some years at Brockton, Mass.

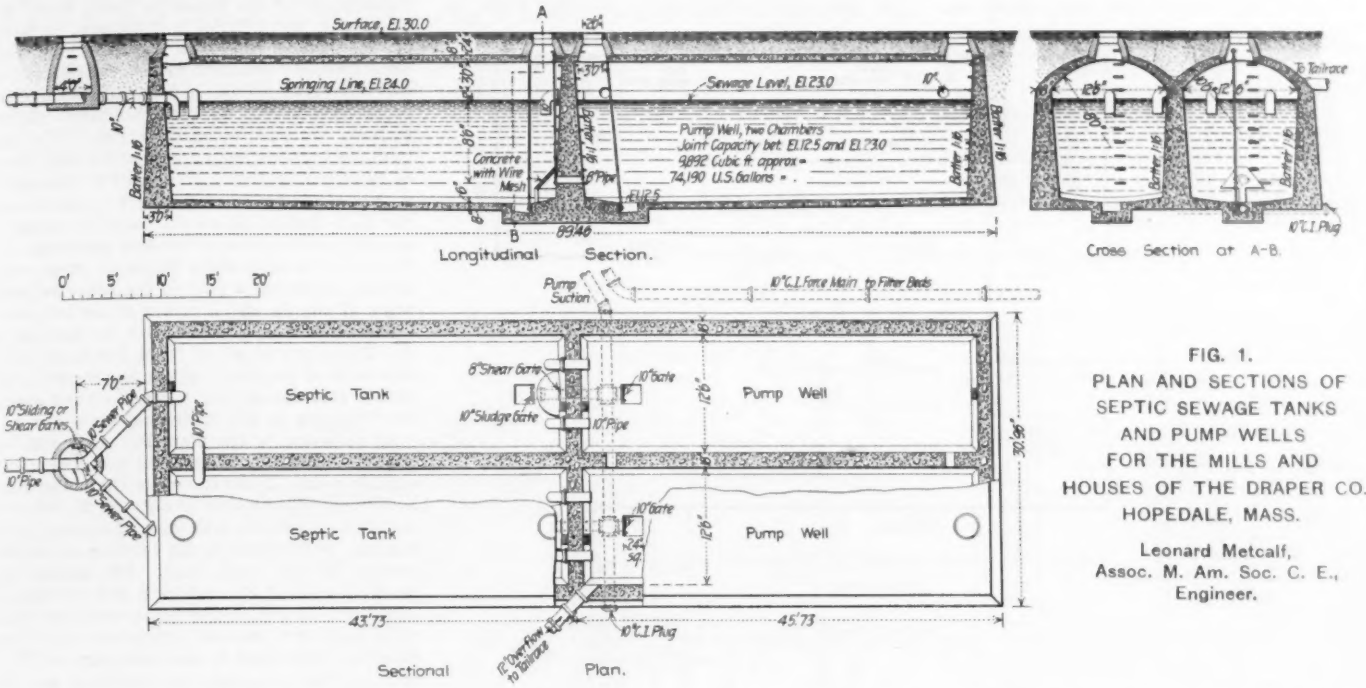


FIG. 1.
PLAN AND SECTIONS OF SEPTIC SEWAGE TANKS AND PUMP WELLS FOR THE MILLS AND HOUSES OF THE DRAPER CO., HOPEDALE, MASS.

Leonard Metcalf,
Assoc. M. Am. Soc. C. E.,
Engineer.

Analyses of Sewage and Effluents from the Disposal Plant of the Draper Co., Hopedale, Mass.

Date of Collection. 1900.	Date of Examination.	Source of sample.	Residue on evaporation: Loss on ignition.†	Fix'd	Total.	P. ct. reduction.	Ammonia: Free. Total.	Free. P. ct. reduction.	Albuminoid. In solution.	Albuminoid. In suspension.	Albuminoid. Total.	P. ct. reduction.	Chlorine.	Nitrogen as: Nitrates.	Nitrites.	Oxygen consumed. Total.	Oxygen consumed. P. ct. reduction.	Hardness.	Iron.
Oct. 18.	Oct. 19.	Sewage in tank[1]	14.40	14.20	28.60	....	3.1500	....	0.2900	0.1300	0.4200	.....	2.78	0.0020	.....	2.84	.....	...	.....
			8.60	12.20	20.80											1.94			
Oct. 18.	Oct. 19.	Tank effluent	17.60	16.00	33.60	....	3.3000	....	0.2300	0.2300	0.4600	.....	3.07	0.0030	.....	3.04	.....	...	.....
			8.60	13.80	22.40											1.90			
Nov. 1.	Nov. 3.	Raw sewage	13.40	8.60	32.00	....	4.2500	....	0.3500	0.1900	0.5400	.....	5.40	0.0030	0.0050	3.60	.....	...	.....
			6.40	16.60	23.00											1.80			
Nov. 1.	Nov. 3.	Tank effluent	10.40	12.00	22.40	30.0	3.1200	26.6	0.2300	0.1000	0.3300	38.9	2.80	0.0030	.....	2.10	41.7	...	.....
			4.80	11.20	16.00	30.4										1.40	22.2		
Nov. 1.	Nov. 3.	Filter effluent[2]	.....	.....	8.70	*61.3	0.2680	*91.5*	.....	.....	0.0132	96.1*	1.95	0.0800	.....	0.06	*97.2*	2.3	0.0030
	1901.		.....	.....	.....	72.9		93.8				97.7					98.3		
Jan. 19.	Jan. 25.	Raw sewage	108.00	24.40	132.40	....	3.5000	....	0.2400	0.2000	0.4400	.....	4.70	.....	.....	7.70	.....	...	.....
			15.40	20.80	36.20											3.20			
Jan. 19.	Jan. 25.	Tank effluent	9.00	7.40	16.40	88.0	2.4200	30.9	0.1400	0.1800	0.3200	27.3	1.82	0.0020	.....	1.90	75.4	...	.....
			5.60	7.00	12.60	65.2										1.40	56.3		
Jan. 19.	Jan. 25.	Filter effluent.[3]	.....	.....	12.00	*26.8	1.3200	*45.5*	.....	.....	0.0552	82.9*	2.70	0.0290	0.0140	0.42	*78.0*	2.0	0.0080
			.....	.....	.....	91.0		62.4				87.5					94.7		
Mar. 9.	Mar. 12.	Raw sewage	26.00	26.60	52.60	....	3.5000	....	0.3500	0.4700	0.8200	.....	3.45	0.0070	.....	5.10	.....	...	.....
			8.00	19.00	27.00											2.50			
Mar. 9.	Mar. 12.	Tank effluent	6.40	11.00	17.40	66.8	2.2700	36.2	0.2400	0.0800	0.3200	61.0	2.10	0.0050	.....	2.40	53.0	...	.....
			6.00	9.40	15.40	43.0										1.30	48.0		
Mar. 9.	Mar. 12.	Filter effluent[4]	.....	.....	12.90	*25.8	1.5000	*31.3*	.....	.....	0.0650	79.8*	2.23	0.0070	.....	0.76	*68.4*	3.6	0.3200
			.....	.....	.....	75.4		56.2				92.1					85.0		

[1]Taken from near inlet of septic tank. [2]This sample showed no turbidity nor color; a slight amount of sediment; a faintly musty color, both cold and hot. [3]This sample showed slight turbidity and sediment; 0.08 color; distinctly disagreeable odor. [4]Decided turbidity; sediment considerable; color, turbid, 0.26; odor, offensive.
*Where two amounts are given the first is the percentage of reduction of septic sewage to filtrate, and the second is the percentage of reduction of fresh sewage to filtrate.
†The second line in these three columns give results after filtering through filter paper.

Provision has been made for the extension of the filtration area as the amount of sewage to be handled increases.

Although the plans for the above described work were completed early in the fall of 1899, construction was not begun until the following spring. On Aug. 18, 1900, the sewage was first turned into the sedimentation tanks, but it was not until Oct. 8 that the filter beds were first used.

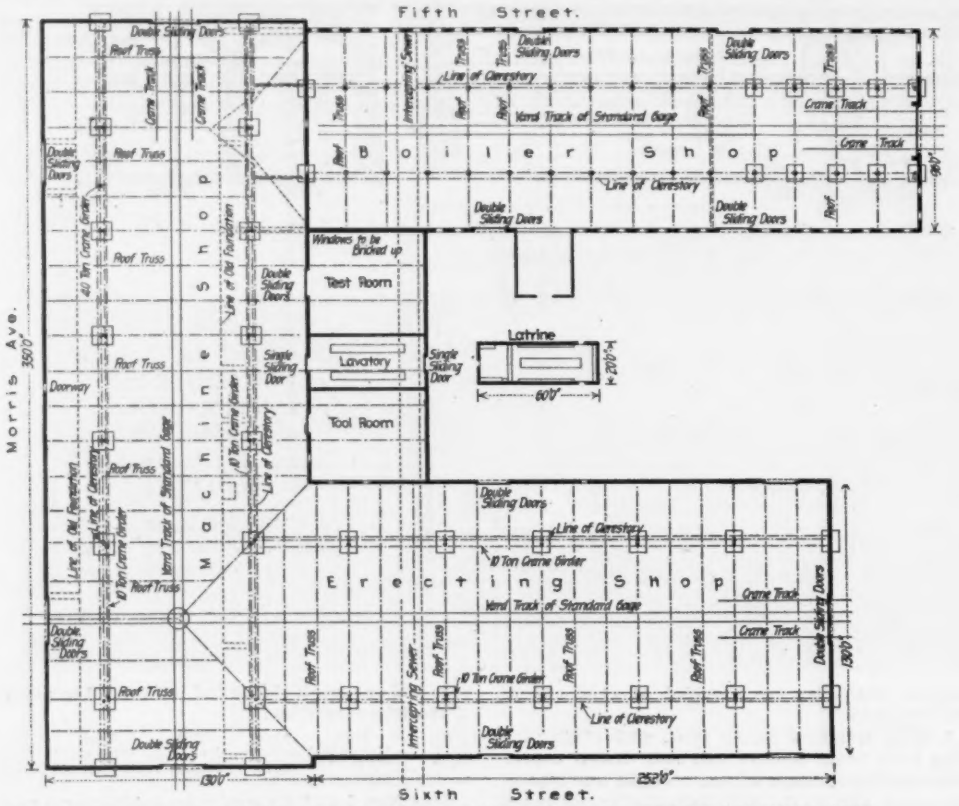


FIG. 1. GENERAL PLAN OF STEAM ENGINEERING BUILDINGS, BROOKLYN NAVY YARD, NEW YORK.

As bearing upon the operation of the plant, it may be of interest to quote from the inspector's notes the references to the formation of the bacterial mat upon the tanks and the character of the sewage effluent:

1900.
Aug. 18.—Turned sewage into tanks at 11:20 a. m.
Aug. 20.—Effluent was very clear with slight odor. Mat commencing to form on top of sewage in septic tanks; none whatever in pump wells.
Aug. 21.—Effluent had quite a strong odor this morning, but still remained clear. Mat formed nearly all over the septic tanks; heaviest near inlet pipes, where it was from ⅛ to ¼-in. in thickness. (This was probably merely floating matter in the sewage and not the bacterial mat.)
Aug. 22.—Effluent could be smelled quite a little distance from the brook, and small stones have a white coating where they come into contact with the sewage.
Sept. 6.—Examined mat on septic tanks and found it very thick at inlet end, say 4 to 5 ins., and moldy on top, but on the other end of tank scarcely any. This, perhaps, due to proximity of overflow pipe. This makes a little over two weeks for the partial formation of the mat.
Sept. 24.—Mat on septic tank about 18 ins. or more thick near inlet end of west tank. This seems to be only local, perhaps from 10 to 12 ft. from end of tank, and rest not so thick, but mat is distinctly formed all over. The odor of effluent was local but strong; stones near it, piled up to give better aeration, being covered with milky bacterial slime. Pump-well walls are covered with fine black sediment.
Oct. 16.—Temperature of sewage: At inlet, 65° F.; at outlet, 63° F.; mat, 74° F.
Oct. 21.—Temperature of sewage: At inlet, 62° F.; at outlet, 62° F.; mat, 66° F. The mat at inlet appeared to be strong enough to nearly hold the weight of a man.

1901.
Feb. 26.—Mat on both tanks about 18 ins. thick, covered with white mold, and many small flies. Temperature of sewage: At inlet, 45° F.; at outlet, 45° F.; mat, 42° F. There seems to be no sediment, or deposit in the bottom of the tanks, so far as can be detected with a sounding stick or rod.

Through the courtesy of Mr. X. H. Goodnough, Chief Engineer of the Massachusetts State Board of Health, it is possible to present a number of analyses of the sewage and effluent made by the board, as shown by the accompanying table.

In commenting upon these analyses it should be said that of the first two samples, that called "sewage in tank" should have been taken in the manhole outside of the tank, but was unfortunately collected from the tank itself at a point near the inlet, after shoving the bacterial mat to one side; for this reason these first two analyses merely indicate the character of the tank effluent. The somewhat poorer results obtained from the sand beds, shown by the last sets of analyses, are due to the cold weather and the overtaxing of beds Nos. 3 and 4, as beds Nos. 1 and 2 were temporarily thrown out of commission during the laying of underdrains in them. The relatively small amount of nitrification shown in all of the analyses is due, of course, to the lateness of the season, when the beds were first put into commission.

THE NEW STEAM ENGINEERING BUILDING FOR THE BROOKLYN NAVY YARD.

We illustrate in the accompanying cuts the general structural details of the new shop buildings now being constructed for the steam engineering department of the Brooklyn Navy Yard, at New York city, by O'Brien & Hoolihan, of Syracuse, N. Y. These buildings replace the machine shop formerly occupied by the department, which was destroyed by fire on Feb. 15, 1899, and occupy in part the site of the older building. Briefly described, the new buildings consist of a machine shop, an erecting shop and a boiler shop, arranged as is shown by Fig. 1, to occupy a U-shaped area. A part of the boiler shop, which forms one arm of the U, is formed by an old building similar in its general construction to the new buildings. In addition to the main shop buildings there will be a latrine occupying a part of the space between the arms of the U, and a power-house set some distance beyond, and in line with the opening of the U. The plans of all of these buildings, with the exception of the power-house, are shown by Fig 1, which also shows the column arrangement and roof framing of the individual buildings.

By referring to the plan, Fig. 1, it will be seen that the machine and erecting shops each have an outside width of 130 ft., while the boiler shop has a corresponding width of only 96 ft. This variation from a uniform plan was, of course, due to the decision to incorporate the existing structure as a portion of the boiler shop. The general framework details of the machine and erecting shops are shown by Fig. 2. The construction of the boiler shop is similar, but the dimensions are, of course, smaller. Referring to the drawings of Fig. 2, it will be observed that the buildings are divided transversely into three bays, a center bay 70 ft. wide and two 30-ft. side bays. The two side bays are covered by shed roofs, above which rise a clerestory and gable roof to cover the center bay. The side wall columns are 12-in.I-beams filled between with a brick wall for a height of about 4 ft., and above this point covered with glazing to the cornice line. The intermediate columns are of lattice and channel construction, and are 43 ft. 6 ins. high, reaching to the level of the junction of the shed roof and the clerestory. They carry between them, longitudinally of the building, a double intersection truss 15 ft. deep, and support a box girder crane runway and the roof columns of the clerestory. The other details are clearly shown by the drawings.

The framework is entirely of steel of from 60,000 lbs. to 70,000 lbs. ultimate strength and an

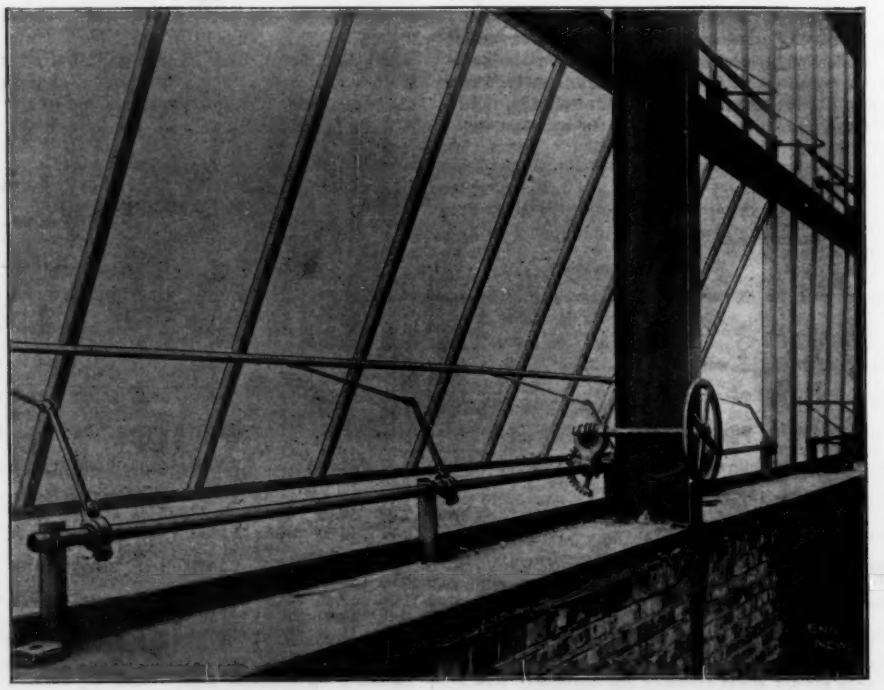


FIG. 3. VIEW SHOWING MECHANISM FOR OPERATING SIDE WALL WINDOWS, STEAM ENGINEERING BUILDING, BROOKLYN NAVY YARD.

elastic limit of one-half the ultimate strength. The specifications for workmanship and other essentials correspond to ordinary first-class practice in these respects. The notable feature of the building is the extent to which glazing has been employed in the side walls and roofing, rather than in any novelty in the framework structure.

The foundations consist of concrete column pedestals carried on piles, the column base plates being anchor-bolted directly to the concrete. The concrete used was mixed according to the Navy Yard specifications, which require that the cement exceeds the voids in the sand about 25%, and that the dry mixture of cement and sand exceeds the voids in the aggregate about 25%. The piles were driven to a final penetration of 1 in. under a 3,000-lb. hammer falling 15 ft. The usual requirements as to soundness of timber and character of cement, sand, aggregate and water were enforced.

The side wall construction for the shed bays, as already stated, consists of a brick base wall with glazing above. This glazing is put on in panels or sections; each is capable of being swung out, as shown by Fig. 3, to provide ventilation. The side walls of the clerestory consist of corrugated iron covering for the lower part, and glazing above. The bulk of the area of the shed roofs is skylight, and wide skylights are also placed in the clerestory roof. The extent and arrangement of this glazing are clearly shown by Figs. 4, 5 and 6. Fig. 4 shows the uncovered steel framing of the machine and erecting shops, and Fig. 5 is a view from practically the same position, showing the wall and roof covering nearly completed. The large proportion of glazing to the total wall and roof area is, perhaps, best shown by the interior view, Fig. 6, as is also the extremely well-lighted condition of the inside of the shop. The entire glazing is on the Paradigm skylight and side light system and was carried out by Arthur E. Rendle, of New York city, who controls the system.

It will be observed from the preceding description that the entire construction is of incombustible materials. There is no wood used in the building, except for the body of the doors, and here it is covered with tin plate. In this respect, and in respect to the amount of glazing used, the buildings are somewhat remarkable, even among modern shop buildings.

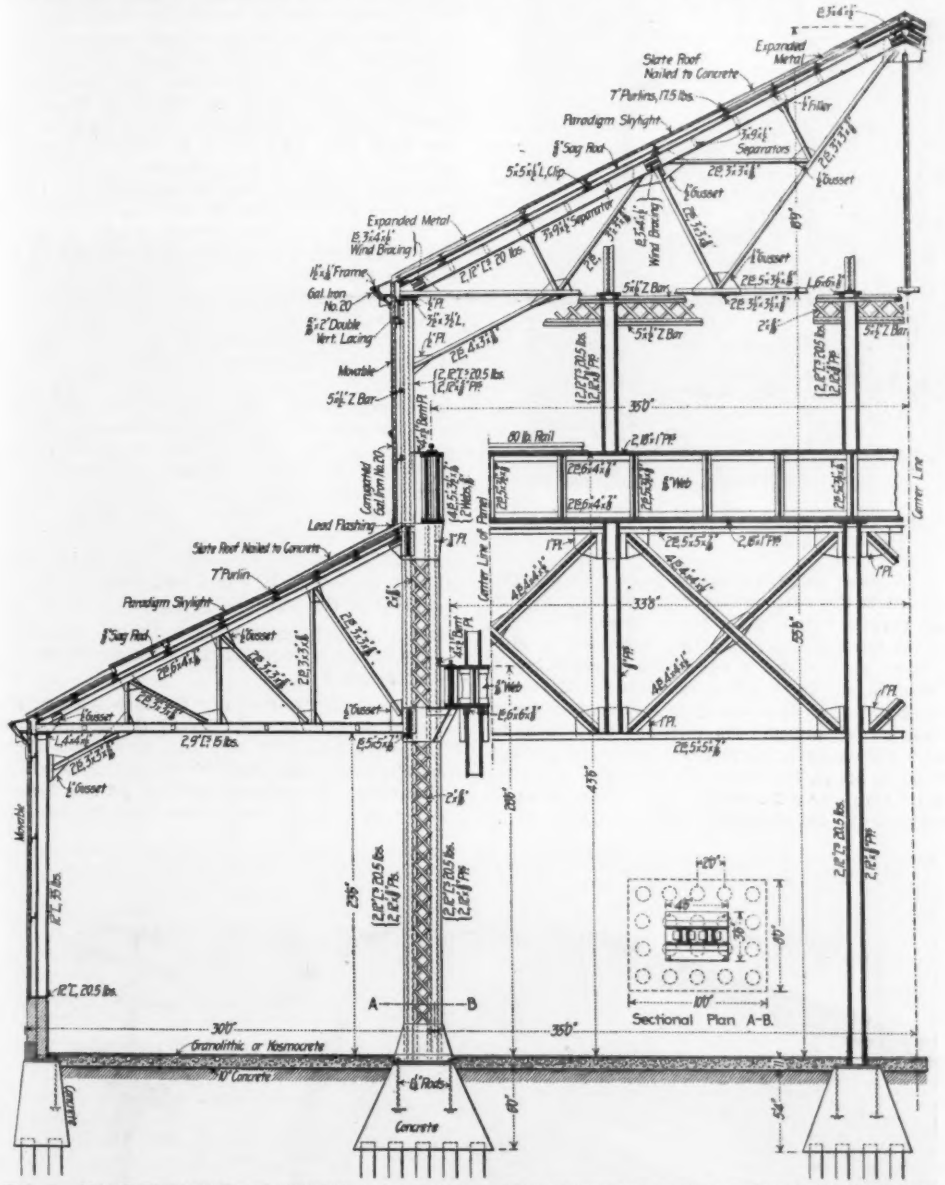


FIG. 2. HALF TRANSVERSE SECTION SHOWING STEEL FRAME DETAILS, STEAM ENGINEERING BUILDINGS, BROOKLYN NAVY YARD.

Turning now to some of the special details, it will be noticed from Fig. 2 that a somewhat unusual construction has been adopted for the main columns. Each column consists of two main members, each composed of two channels riveted back to back, the two main members being connected by double latticing. The resulting section is rather remarkable for its length, as compared with its width, but its purpose was evidently to give ample flexural strength to withstand eccentric load of the bridge crane girders. Details of the crane girders and crane tracks are shown by Fig. 2. Fig. 6 shows the cranes in position; there being one 40-ton crane and two 10-ton cranes. It will also be observed from Fig. 2 that the lower portion of the clerestory roof has a concrete and expanded metal covering with roofing slate nailed direct to the concrete. The concrete is composed of Portland cement and cinder, and is 3½ ins. thick. The floor construction throughout will be 10 ins. of concrete covered with 1 in. of granolithic or Kosmocrete. In the tool and testing rooms off the machine shop, and between the boiler and erecting shops, an effort has been made to secure a dust-proof construction, and a roof which will be free from drippings due to condensed moisture. Over these rooms the skylight roofs consist of double-glazed Paradigm Skylights, with a 1-in. air space between them. The lavatory and latrine appliances and fittings are first-class in every particular of design and construction. The other principal details are clearly shown by the illustrations.

The building described above has been designed and erected under the direction of Rear Admiral P. C. Asserson, Civil Engineer U. S. N., M. Am. Soc. C. E. The designs for the steel work were made by Lieut. E. P. Goodrich, Civil Engineer, U. S. N., Jun. Am. Soc. C. E., and the plans approved by Rear Admiral M. T. Endicott, Civil Engineer, U. S. N., M. Am. Soc. C. E., Chief of the Bureau of Yards and Docks.

THE SANITARY CLEANING OF GALVESTON AFTER THE GREAT STORM OF 1900.*

By George A. Soper, Ph. D., Assoc. M. Am. Soc. C. E.†

The great storm at Galveston, Tex., on Sept. 8, 1900, had a serious effect upon the sanitary situation. It brought about conditions which made a thorough cleaning of the city necessary, and at the same time destroyed the means by which this could have been most readily accomplished.

Most of the usual outlets for the wastes of the city were destroyed or rendered temporarily useless by the flood. Drains and gutters were choked. Thousands of outhouses were demolished or moved from their proper places, and the contents of vaults and cesspools were carried off by the water which swept for several hours over the city.

Immediately after the storm an army of rescuers, curiosity-seekers and adventurers, flocked to the scene and added new difficulties to the work of caring for the survivors of the flood. Partly-ruined houses were hunted out and put in shape for occupancy by the flood sufferers, or those who pretended to have been rendered destitute by the storm. The house cleaning done by these people was generally of a simple order. Articles of upholstery, etc., which had been injured beyond repair, and could not be dried or otherwise recovered from the foul odors which frequently enveloped them, were thrown out without thought of their final disposal. Garbage was disposed of in the same manner. Wastes of all kinds accumulated in the yards, streets and alleys, where the decomposable portions soon became offensive. Under these circumstances, it is not strange that what was locally termed a pest of flies, made its appearance.

It was at length evident that the large number of people who were living in this manner were producing conditions dangerous to the public health. It was seen that an outbreak of any of the acutely infectious diseases, but especially yellow fever, would be likely to spread with great rapidity should it once gain a lodgment. Such an epidemic, attended as it would have been by the hardships of a southern shotgun quarantine, would have proved a greater blow to the city than the storm. As though to point out the reality of this danger, an epidemic of diarrhœa made its appearance. The disease was not apparently of the amœbic type, and resulted in but few fatalities, yet in a term of less than three weeks, more than 80% of the inhabitants were attacked.

GENERAL PLAN FOR CLEANING THE CITY.

Upon reaching Galveston it was apparent to me that there was need of energetic measures to correct the existing evils and put the city in a strictly sanitary condition. Acting in accordance with the request of the Central Relief Committee, a general plan of procedure was made, as follows: I proposed to establish a line of easy outlet for the filth by means of an efficient system of street cleaning, and to apply such pressure as might be available

*Extract of a report made to the Chamber of Commerce of the State of New York.

†29 Broadway, New York.

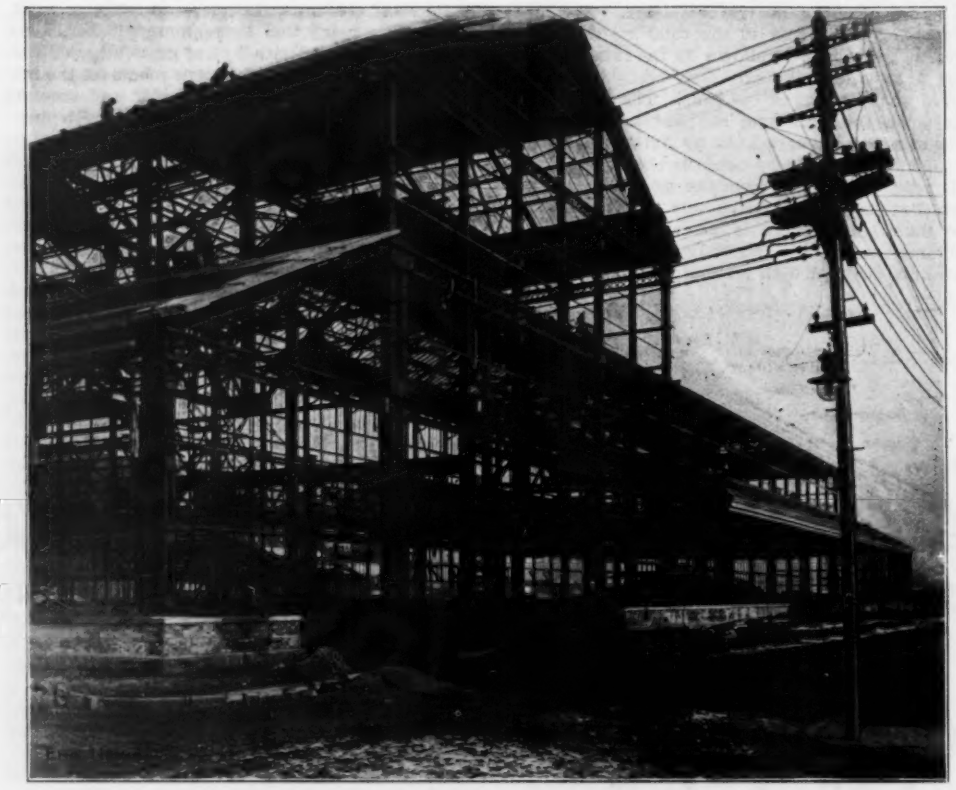


FIG. 4. VIEW SHOWING PORTION OF FRAMEWORK UNCOVERED, STEAM ENGINEERING BUILDINGS, BROOKLYN NAVY YARD.

to compel the householders to observe the city ordinances relating to sanitation. I was of the opinion that most of the filth of houses and yards would thus naturally find its way to the streets and alleys, and that the people, if suitably directed and encouraged, could be of considerable assistance in the general cleaning. By seeing that garbage and refuse, placed outside in proper receptacles, as provided by the ordinances, was promptly removed, and requiring that the people observe the ordinances from the beginning, there was no trouble in making a rapid disposition of the wastes.

ORGANIZATION OF THE SANITARY FORCE.

A sanitary department was organized and directed as follows:

(1) The city was divided into five sanitary districts. The area of each district was inversely proportional to the density of the population and to the quantities of refuse which repuired removal. The force was disposed of in the districts in such a way that the garbage, papers and the like, which accumulated with tolerable regularity, could be removed by carts. The carts followed routes which were covered daily in the thickly populated sections, and three times a week in the rest of the city.

(2) The number of garbage carts belonging to the health department was greatly increased, and a competent foreman was put in charge of the corps. The garbage was hauled to the east end of the city, and dumped where it might be burned by the aid of house wreckage.

(3) Dead animals were removed at the owner's expense, and referred to the foreman of the garbage carts for incineration near the dumps.

(4) Paper, house-sweepings, etc., were collected in large drays. The paper and other dry refuse was used to fill land.

(5) A third corps was engaged in collecting and disposing of the offensive accumulations, other than garbage, which had gathered in streets and alleys. The force consisted of high-bodied coal drays of 36 cu. ft. capacity, and laborers provided with hoes and shovels. The drays and laborers were divided into gangs; three laborers to one dray, and from two to four drays to one gang, afforded the most satisfactory results. With a haul of 3½ miles, and an average of 8⅛ loads per day, the cost of scraping and removing this material was 67.3 cts. per cu. yd.

(6) A small corps of sanitary inspectors was put to work in the various districts. Its duty was to visit private premises for the purpose of inspecting the condition of yards and outhouses, to give sanitary advice, and if necessary to serve board of health notices that householders would be required to put their property in satisfactory order within a brief period. The men had note-books in which the conditions found were recorded and reported to me at the close of each day.

(7) There was a force of carts and men detailed to distribute disinfectants. Lime, carbolic acid, sulphate of iron and creolin were used in places from which objectionable matters were taken. Stagnant gutters, foul-smelling alleys, and private and public outhouses frequently received such treatment before it was expedient to clean them out. For work of this kind, unslaked lime, distributed as generally as possible over the offensive area, was found useful. A saturated solution of copperas was occasionally employed to arrest decomposition. Creolin, mixed with water, was used in a watering cart employed to sprinkle streets in the business portion of the city. The watering cart held about 600 gallons, and to nearly this quantity of water half a barrel of creolin was added. A stronger mixture would have been desirable, but would have probably caused complaint from pedestrians. The creolin produced an agreeable counter odor to the emanations from the gutters, and appreciably reduced the number of flies in the streets which were sprinkled. Crude carbolic acid was used with good effect in treating stagnant pools of water which were offensive because of decomposing organic matter contained by them. Whenever possible, shallow pools were drained off or filled with dry sand, broken bricks or shells. If very shallow, a thorough raking facilitated an absorption of the water by the soil. Special directions were given in all cases to use disinfectants in such a way that they might reach all the particles of the offensive substances to be treated.

It was necessary to dispose of the bodies of dead persons and animals by burning and by burial, and circumstances usually required that this should be done close to the place where the bodies were found. Owing to the fact that the ground water in Galveston lies within a few feet of the surface of the ground, burning was the method of disposal generally followed. The bodies were placed upon large bonfires which were kept burning until the remains were consumed. Where burial was necessary, it was found desirable to use quicklime in the trenches.

RESULTS ACCOMPLISHED AND SUGGESTIONS FOR CONTINUING WORK OF SANITATION.

The work of the sanitary force resulted in the removal of a large quantity of the accumulated filth. In a period of less than two weeks there were cleaned five hundred blocks of streets, alleys and gutters. Upwards of 2,000 cu. yds. of decomposable or decomposing refuse were removed in

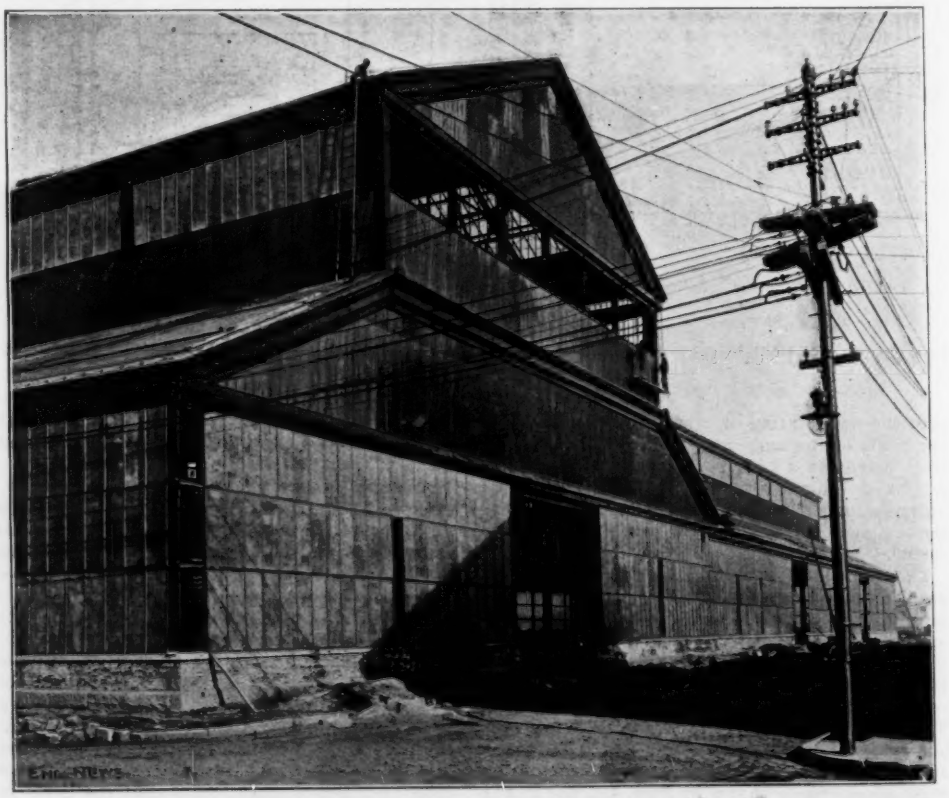


FIG. 5. VIEW SHOWING PORTION OF BUILDING WITH COVERING IN PLACE, STEAM ENGINEERING BUILDING, BROOKLYN NAVY YARD.

this period. A regular system of garbage and refuse collection was established. In a gratifying measure the apparent indifference of the people toward sanitary regulation gave place to a sentiment in favor of an enforcement of the city health ordinances. In many ways the people themselves contributed to the work of the department. Private individuals, business firms, the railroads and wharf company, and a considerable number of foremen engaged in the separate task of cleaning away the debris of buildings, etc., did useful sanitary work, and deserve recognition for the part they took in the general cleaning.

None of the acutely infectious diseases which were feared at the time of my arrival, gained a footing.

The following suggestions were made at the request of a committee of the physicians of Galveston, who desired me to state upon my departure from the city, the main points which appeared most essential in continuing the work of the department:

(1) A careful observance of the health ordinances by the people. This should be accomplished by methods of moral suasion where feasible, and by legal force when necessary.

(2) A regular and reliable collection of garbage, paper and other refuse, and a permanent disposal of the same in a sanitary manner.

(3) A force of drays and laborers under competent direction to correct especially foul, infected, or otherwise dangerous localities.

(4) A final disposition of the wreckage and ruined houses, preferably by burning.

(5) A careful watch for cases of infectious diseases, so that disorders which might become epidemic can be intercepted at their origin.

(6) It is recommended that the contractor for street cleaning be authorized to continue his operations, and that the various persons formerly engaged in the occupation of removing night soil be encouraged to resume their business.

(7) It is advised that an effort be made to keep the streets and gutters clear of obstructions, and that they be flushed, dried or disinfected according to their several needs, so that they may not present an unsightly and offensive appearance. In the absence of a suitable gradient, the gutters, especially in the business portion of the city, should be kept as dry as possible. To this end laundries, restaurants, barber shops, etc., whose liquid wastes find their way into the streets, should be required to secure outlets to the sewers.

(8) The sewers intended for the accommodation of liquid household wastes, and those built to carry off storm water from the streets, should be examined for obstructions, and, when clear, flushed with water.

FIG. 6. INTERIOR VIEW OF STEAM ENGINEERING BUILDING, BROOKLYN NAVY YARD.

BOOK REVIEWS.

OFFICIAL COMMERCIAL DIRECTORY OF CUBA, PORTO RICO AND THE ENTIRE WEST INDIES, WITH BERMUDA, FOR 1901. Containing complete commercial lists and descriptions of the various islands and colonies, their customs tariffs, statistical information, etc. Three volumes in one. Compiled and published by The Spanish-American Directories Co., Singer Building, 149 Broadway, New York. Boards, 5¾ × 9⅛ ins.; pp. 942. $5.

The information contained in these directories is given in both English and Spanish, so that they are equally available in this country and in the West Indies. In all cases, excepting for the English islands, the business directories are arranged under cities and provinces in alphabetical order, with the trades or establishments of various kinds noted in both languages. The customs tariff of the islands is in English only. The descriptive matter is full; covering climate, agricultural and mineral resources, civil conditions, finances, geography, etc.

THE RUSSIAN JOURNAL OF FINANCIAL STATISTICS.—Issued annually. Subscription price, $5. St. Petersburg: 23 Millionnaia. New York: G. E. Stechert, 9 East 16th St.

This new publication is a volume of over 700 pages, containing a large amount of statistical information relating chiefly to the operations of Russian corporations, and to Russian government finances. It is, in fact, a sort of "Poor's Manual" in the information it gives with respect to the finances of corporations operating in Russia, and contains in addition a wide range of matter on other subjects, such as Russian mining and railway enterprises, labor and factory legislation. The number of the journal before us, notwithstanding its bulk, is issued for free distribution, and the publishers offer to forward a copy free to any address on receipt of 2 shillings, or 48 cts. in English or United States postage stamps, forwarded to the St. Petersburg address, given above. Anyone at all interested in Russian matters will be well repaid by taking advantage of this offer. It should be added, perhaps, that the work is printed in English.

A TEXT-BOOK OF MECHANICAL DRAWING AND ELEMENTARY MACHINE DESIGN.—By John S. Reid and David Reid, Instructors in Mechanical Drawing and Designing in Cornell University. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 389; illustrated. $3.00.

In this book an attempt has been made to show the best American practice in the design and construction of various machines and their details, with the latest drafting-room methods. The books on machine design already existing are mostly of English or German authorship. They have been used to some extent in this country, but they are by no means all that could be desired in the way of a presentation of modern American practice. The present volume is a valuable contribution to the needs of American engineering students. The scope of the work may be shown by some of the chapter headings, as follows: Screws, Nuts and Bolts; Rivets and Riveted Joints; Shafting and Shaft Couplings; Bearings, Sole-Plates and Wall Box-Frames; Belt Gearing; Toothed Gearing; Valves, Cocks and Oil Cups; Engine Details.

STEAM-BOILER ECONOMY.—A Treatise on the Theory and Practice of Fuel Economy in the Operation of Steam Boilers. By William Kent, A. M., M. E., Consulting Engineer; Associate Editor of Engineering News; Author of "The Mechanical Engineer's Pocket Book"; Member American Society of Mechanical Engineers, American Institute of Mining Engineers, American Society of Heating and Ventilating Engineers. New York: John Wiley and Sons; 8vo.; cloth; pp. XIV + 458; 126 illustrations. $4.00.

In accordance with our usual custom in presenting reviews of books written by members of the editorial staff of this journal, we confine our notice of this work to the following reprint of the preface:

In the year 1875 the author made his first evaporative test of a steam boiler. It was the Pierce rotating boiler, which was tested at the Centennial Exhibition the following year. It had certain peculiarities of design which were supposed by the inventor to make it more efficient than any other boiler then on the market. The testing of this boiler and of two others during the same year led the author to study seriously the problem: "On what conditions does the fuel economy of a steam boiler depend?" For three years, 1882-5, he was in the employ of the Babcock & Wilcox Co., and it was part of his work to make evaporative tests of the boilers made by that company, and of other kinds of boilers for comparison, in different sections of the country, and with all kinds of coal. In connection with his office practice from 1890 to the present time, he has had occasion to make nearly a hundred boiler tests, with different boilers, fuels, and furnaces. Besides having this practical experience, together with the habit of studying critically the result of each test for the purpose of drawing conclusions from it, the author has been a constant student of the literature of the subjects of boiler testing and fuel economy, which from time to time appears in the transactions of engineering societies, in the technical press, in trade catalogues, and in books. He has thus been enabled to compare theory with practice.

Many books have been written on the subjects of boilers, furnaces, and fuels, but in none of them does it seem that the problem of steam-boiler economy has been treated with the thoroughness which its importance deserves. Most of the treatises on boilers devote the greater part of their space to details of construction, and only a small space to the subject of fuel economy. There appears to be a demand for a new book which shall treat solely of steam-boiler economy and of subjects related thereto. To supply such a demand this book is offered.

A few words as to the plan and scope of the book. The first chapter contains a statement of principles and definitions and a very brief survey of the whole ground intended to be covered in the remainder of the book. Chapter II. treats of the chemistry of fuel and of combustion, of the heat generated by combustion, and of the temperatures produced under different conditions. The discussion of the subject of temperature is believed to be more complete than that given in any other work. Chapter III. is a brief one on coal and its heating value, including a table of analyses and heating values of American coals. Chapter IV. is much longer, and is a condensed treatise on the coal fields of the United States, giving their location, with the analyses of the coals mined in each state or district. The space given to this subject is believed to be justified by the close relation which exists between the economy of a boiler and the quality of coal used in it. Chapter V. is a discussion of tests of the heating values of American and foreign coals, and shows the relation of the heating value to both the proximate and the ultimate analysis. It reviews the work of Johnson and of Lord & Haas on American coals, and of Scheurer-Kestner, Mahler, and Bunte, on foreign coals. Chapter VI. treats of fuels other than coal, including peat, oil, gas, bagasse, etc. Chapter VII. treats of furnaces, methods of firing, smoke prevention, mechanical stokers, and forced draft.

In Chapter VIII. the discussion of the boiler itself, and of the efficiency of its heating surface, begins. The plain cylinder boiler is taken as the simplest form, and in an elementary manner it is shown how the fuel economy depends on the rate of driving as well as on other conditions. In Chapter IX. the same subject is considered further by the mathematical method. There is here published for the first time a formula for efficiency of heating surface which contains all the variables affecting the problem that are measurable. They are: heating value of the fuel, temperature of the water in the boiler, radiation, weight of chimney gas per pound of combustible, and rate of driving. It contains only one coefficient of performance, "a," which is not measurable as a concrete quantity, but is a figure that may be derived from the results of boiler tests, and is useful in comparing one test with another. Much of this chapter will be skipped by those who are not accustomed to the use of algebraic formulæ, but the conclusions which follow the mathematical treatment are of great importance, and should not be neglected.

Chapter X. illustrates and briefly describes the various types of steam boilers now on the market, and shows the evolution of many of them from earlier forms. Chapter XI. discusses boiler horse-power, proportions of grate and heating surface, and boiler performance. Chapter XII. treats of the "points" of a good boiler, and will be found useful to those who are contemplating the purchase of a steam boiler. Chapter XIII. discusses "boiler troubles and boiler-users' complaints," and contains much information that should be serviceable to boiler users. Chapter XIV. treats of boiler testing and includes the "Code of 1899" adopted by the boiler-test committee of the American Society of Mechanical Engineers, of which committee the author was a member. Chapter XV. gives the results of several boiler tests, together with conclusions drawn from them. Chapter XVI. gives tables of properties of water and of steam, factors of evaporation, and a brief discussion of chimneys, with the author's table of chimney proportions. Chapter XVII. is a miscellaneous assortment of subjects relating to boiler economy which were not included in previous chapters.

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In discussing the prospect of New York canal improvement work in our issue of March 21 we said, after reviewing the situation:

> It can be predicted with much confidence that for the present, at least, New York will undertake no radical scheme for canal enlargement.

Since that time a bill providing for the submission of an appropriation of $26,000,000 to popular vote, drafted with the approval of Governor Odell and some of the principal State officers and political leaders, has been introduced in the Legislature. At one time it seemed possible that it might be made a party measure and thus secure passage. On April 17, however, those who had favored the bill became convinced of the impossibility of its success, and it was decided to abandon it. For at least a year to come, therefore, until another Legislature assembles, no action can be taken toward the enlargement of the New York canals. Inasmuch as any action by the Legislature providing for canal enlargement by the issue of State bonds must be submitted to popular vote, this puts off any definite decision as to the improvement of the New York canals at least until the fall of 1902.

The $26,000,000 scheme of canal improvement provided for barges of 450 tons capacity and it received its strongest support from the Buffalo delegation. Such barges would have to be loaded from Lake steamers at Buffalo, like the present canal boats, and this is the sort of canal for which Buffalo most yearns. New York city interests, however, desire a bigger canal, one which can take boats big enough and staunch enough to bring cargoes from any of the lower Lake ports without stopping to pay tribute to Buffalo. The 1,000-ton barge canal, recommended by the Greene Commission last year, just suits New York city, and it is not at all improbable that the Legislature in session a year hence may have the 1,000-ton barge canal scheme brought before it.

Will it have any better fortune than has attended the 450-ton barge scheme? While long-range speculation is always risky, it is certainly true that from present appearances, the prospects of its ultimate success are far from bright. Its promoters will be confronted at the outset by the dilemma whether to choose the $50,000,000 route via Lake Ontario, or the $70,000,000 route via the Seneca River. If they choose the former, Buffalo will doubtless throw all her influence against the project; for if the boats to use the new route are built to navigate Lake Ontario, they can run on Lake Erie as well. If they choose the $70,000,000 route, however, the defeat of the scheme, when submitted to popular vote, is rendered so much the more certain. In fact, a popular vote in favor of even the $50,000,000 appropriation seems extremely improbable.

This journal, as our readers are aware, has not been numbered among the enthusiastic advocates of ship canal construction between the Great Lakes and the ocean. Nevertheless, the project for a 21-ft. ship canal from Lake Ontario to the Hudson, on which the United States has spent nearly half a million dollars for surveys, appears to us more likely to be realized than any of New York's schemes for enlarged canals. We venture no opinion as to the economy of a 21 ft. channel as a transportation route compared with the proposed 1,000-ton barge canal. That question is too knotty and disputed a one to have much influence in determining the fate of either proposition. We merely point out the fact that there are huge difficulties to prevent the realization of any of New York's schemes, whereas to carry out the project for a United States deep waterway, all that is required is favorable action by Congress.

And the securing of such action might not prove so very difficult. The geographic sections directly interested in such a canal and whose representatives would all or nearly all be expected to favor it include New England, New York and New Jersey, all the States bordering on the Great Lakes, Iowa, Nebraska and the Dakotas. In the last Congress these States had 174 representatives out of a total membership in the House of 357. The new apportionment will very likely give these States a clear majority in the House. Under these circumstances, whenever public opinion in these States clearly demands the construction of the proposed deep waterway, Congress is likely to provide for it.

The use of machinery to aid the "mucking gang" in tunnel excavation is described elsewhere in this issue by the engineer in charge of a tunnel nearly two miles long in the Cour d'Alene district, Idaho. A drag scraper was used, which was hauled by a compressed air hoist up an incline where it could dump its contents into a car. The rock penetrated appears to have broken up into small fragments in blasting, so that it was readily handled by the scraper. Had this not been the case, more difficulty would probably have been experienced in the use of the apparatus. On the other hand, in driving the Cascade tunnel for the Great Northern Ry., described in our issue of Jan. 10, a hoisting machine was used for lifting into the cars stones too large to be raised by hand, and a large amount of labor in "block-holing" was thus saved. These two examples illustrates the advantage of mechanical appliances for handling muck in tunnel excavation, both on rock that breaks in coarse fragments and rock that shatters. It is a matter well worth the attention of engineers engaged in tunnel work.

The complaint regarding the damage caused by blasting for the Rapid Transit tunnel in uptown New York leads the "New York Times" to suggest that high explosives should be discarded on this work and in their place should be introduced "heat and cold acting in their normal way by expansion, contraction and the displacing force of ice." Coming down to details, it advises the contractors to try injecting first steam and then liquid air into the drill holes, and predicts that "internal strains would thus be set up which not even adamant could resist." In proof of the practicability of this scheme, the "Times" says that "at the foot of every cliff we find a great accumulation of detritus detached by silent but irresistible forces."

Our contemporary forgets that the detritus at the foot of a cliff usually represents the result of many thousand years' action of these "silent but irresistible forces." New York can't wait that long for its Rapid Transit railway.

Blasting has been in progress in uptown New York for more than a quarter century, and a good share of the rock which originally covered most of the upper part of Manhattan Island has been blasted away to a considerable depth in excavations for streets, sewers, water mains, cellars, etc. The Rapid Transit rock excavation is a trifle compared with what has already been done; and while accidents happen occasionally, there is no reason why they should be any more frequent than in the other rock excavation work in the same locality.

Two serious difficulties are now confronting the Board of Trustees of the Sanitary District of Chicago, who have charge of the Chicago Drainage Canal, and the Board is placed in a position where wise and careful management will be required. The present situation involves the interference of Federal with State legislation. By the State law of Illinois, under which the legal authority for the construction of the canal was given, the flow through the canal was fixed at a minimum of 300,000 cu. ft. per minute, the same to be increased in proportion to the population resident on the area which delivers its sewage to the canal, and which area constitutes the Sanitary District. Any failure to observe this statute requirement will at once make trouble with the cities and towns along the Illinois River, whose consent to have Chicago's sewage flow past their doors was only given on condition that the stated dilution with water from Lake Michigan should be maintained.

Experience has shown, however, that with a flow at the above rate through the Chicago River to the canal, a current is set up in the river which renders navigation at bridge openings and other narrow points in that narrow and much-obstructed stream very difficult for the large modern lake steamers. These vessels fill so large a part of the river's cross-section at these points that they are almost helpless in the current, even when it is moving at a rate which would be of little importance in a broad or unobstructed stream where the vessels would at least have steerage way. These conditions were shown in our issue of Aug. 9, 1900. We have official information to the effect that vessels navigating the river have not encountered any harmful results in the wider stretches, but only at the bridges and other narrow points above referred to, where the work of the Sanitary District is yet incomplete.

For some months past, however, the navigation and commercial interests have been protesting against the present condition of affairs, and their protests have recently resulted in an order from the War Department restricting the flow in the Drainage Canal to 200,000 cu. ft. per minute. Evidently the trustees will have to obey this as being superior to the State law, and let St. Louis and the Illinois towns do their worst. Some of the authorities whose opinions upon this matter have been given, consider that under present conditions a flow of 200,000 cu. ft. per minute is ample for the dilution of the sewage, so that there need be no apprehensions on this score from a sanitary point of view.

The waters of Lake Michigan belong not to any State but to the United States Government, represented in regard to all navigable waters by the Secretary of War. The right of the Federal government to control its property is unquestionable, and is superior to any State law based upon the assumption that any one State may help itself without restriction from the property which the United States Government holds in trust for all the States. Hence, the trustees must obey the

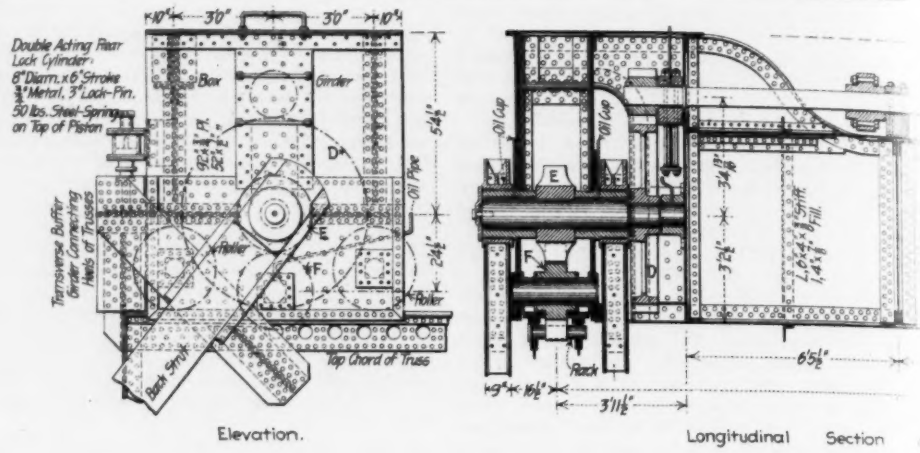

Double Acting Rear Lock Cylinder. 8" Diam. x 6" Stroke. ¾" Metal, 3" Lock-Pin. 50 lbs. Steel Springs on Top of Piston
Box Girder
Oil Pipe
Roller
Transverse Buffer Girder Connecting Heels of Trusses
Back Strut
Top Chord of Truss
Oil Cup
Rack
Elevation.
Longitudinal Section of Box Girder.

FIG. 6. OPERATING MACHINERY.

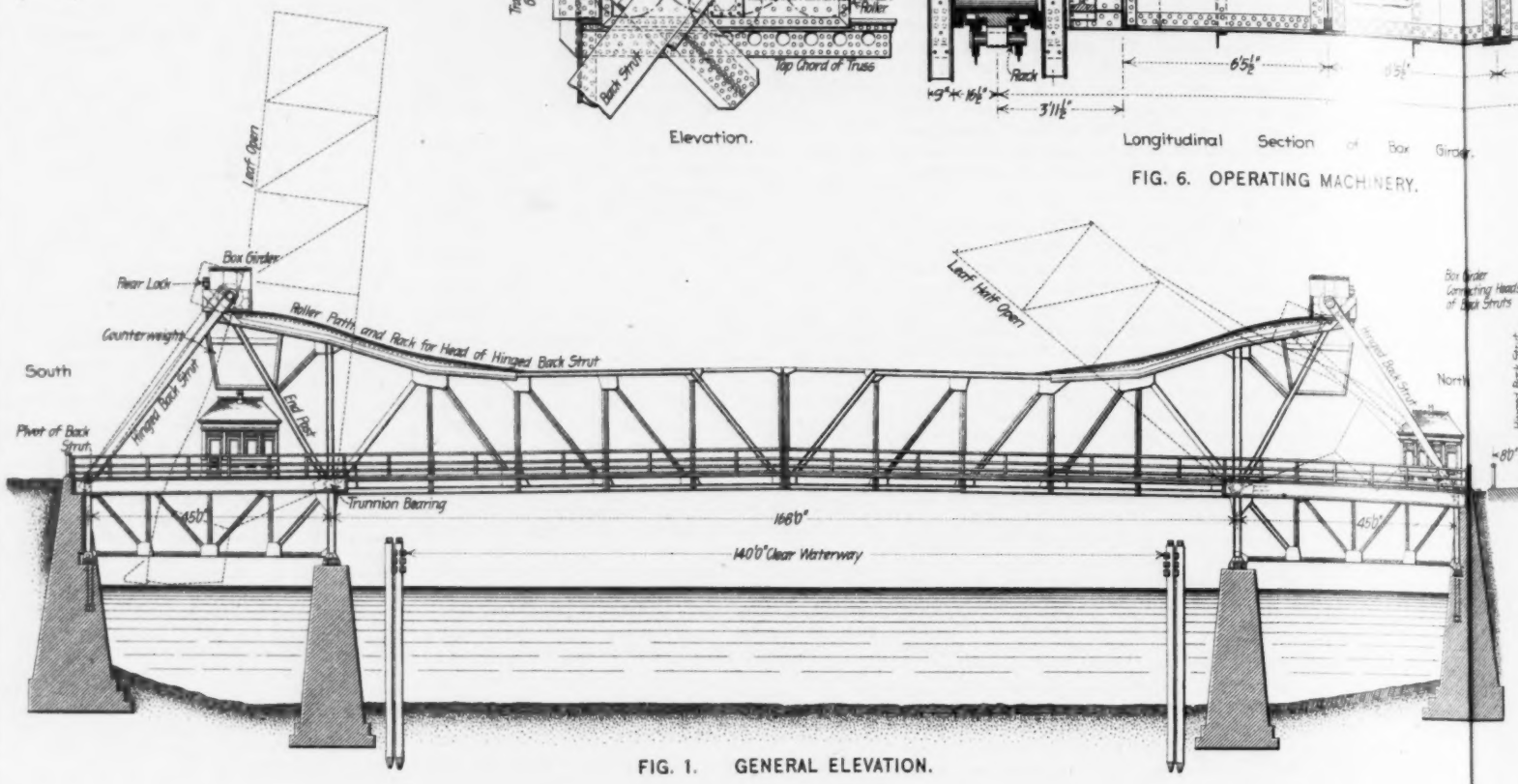


FIG. 1. GENERAL ELEVATION.

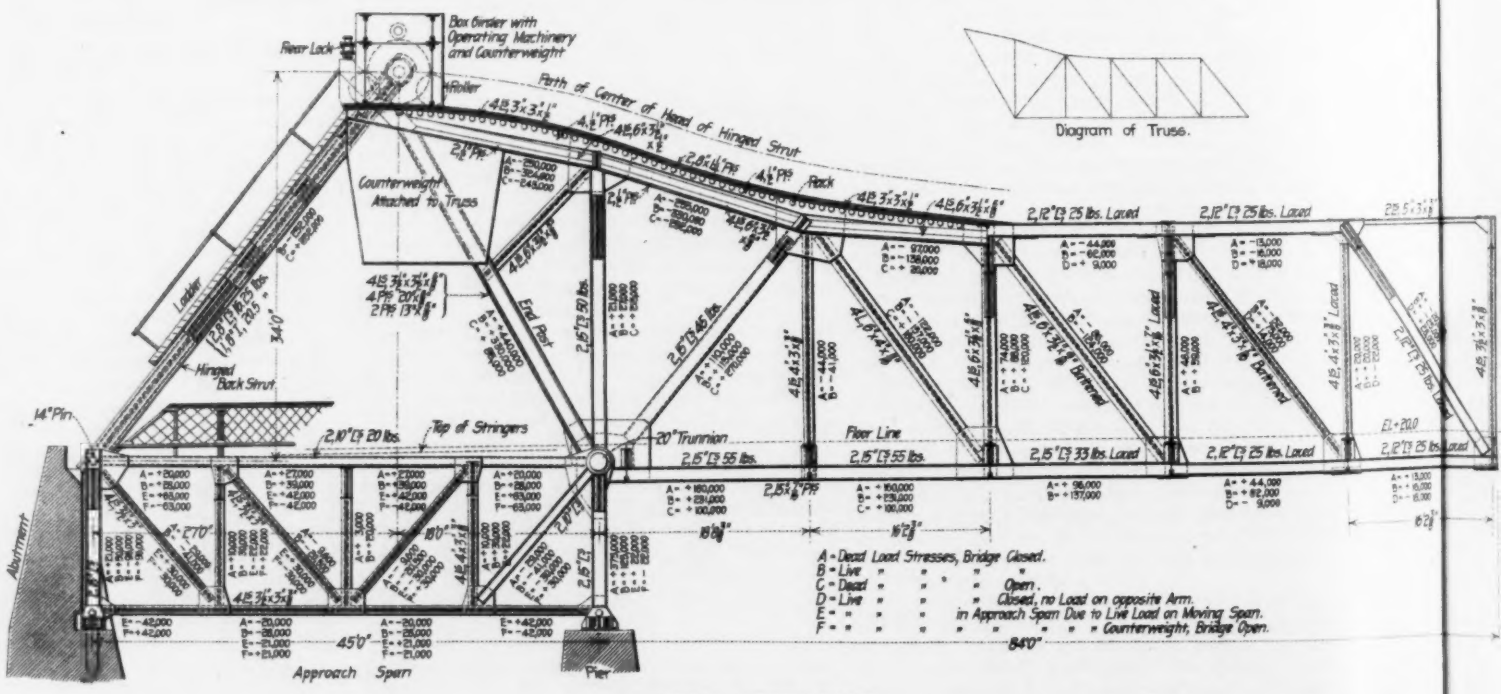
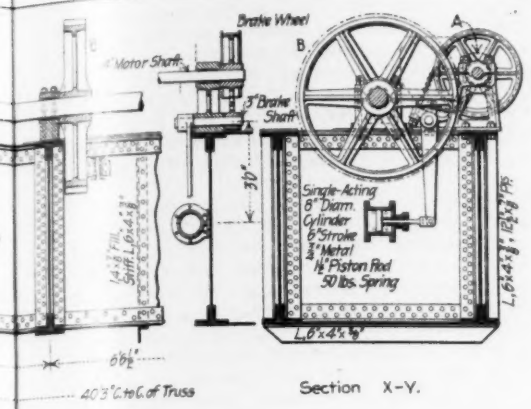

Box Girder with Operating Machinery and Counterweight
Rear Lock
Roller
Path of Center of Head of Hinged Strut
Rack
Counterweight Attached to Truss
Ladder
Hinged Back Strut
End Post
14" Pin
Top of Stringers
20" Trunnion
Floor Line
Abutment
Pier
Approach Span
45'0"
84'0"
Diagram of Truss.
A = Dead Load Stresses, Bridge Closed.
B = Live " " " "
C = Dead " " " Open.
D = Live " " " Closed, no Load on opposite Arm.
E = " " " in Approach Span Due to Live Load on Moving Span.
F = " " " " " " " " Counterweight, Bridge Open.

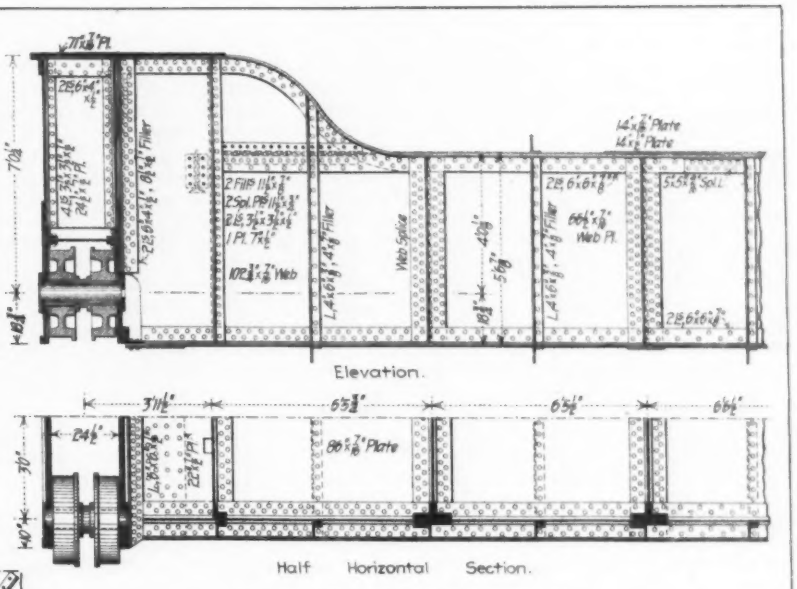
FIG. 3. STRAIN SHEET.

BASCULE BRIDGE OVER THE CHICAG

John W. Page, Inventor. W. M. Hughes, M.



Section X-Y.



Elevation.

Half Horizontal Section.

FIG. 7. ROLLERS OF BACK STRUT.

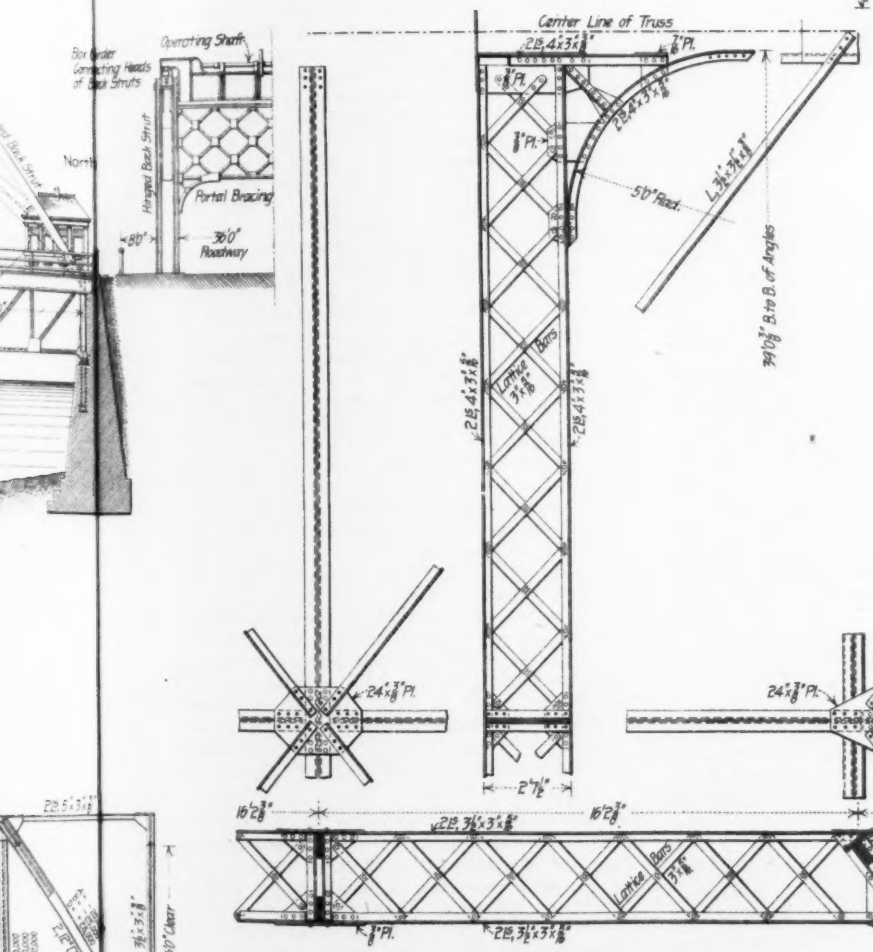


FIG. 2. PORTAL AND TOP LATERAL BRACING.

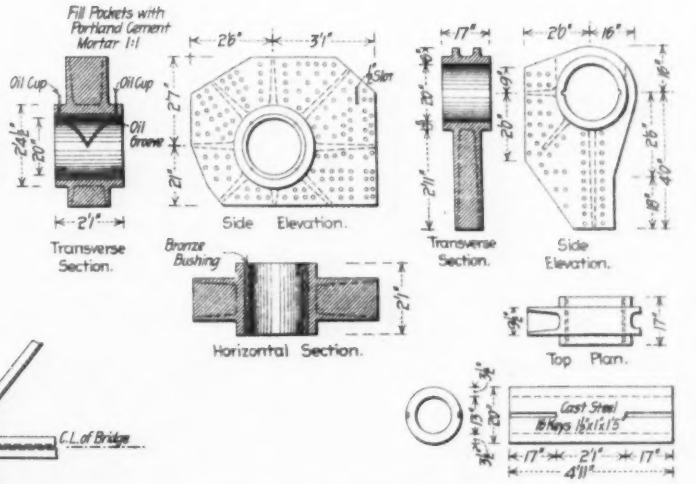


FIG. 5. TRUNNION BEARINGS.

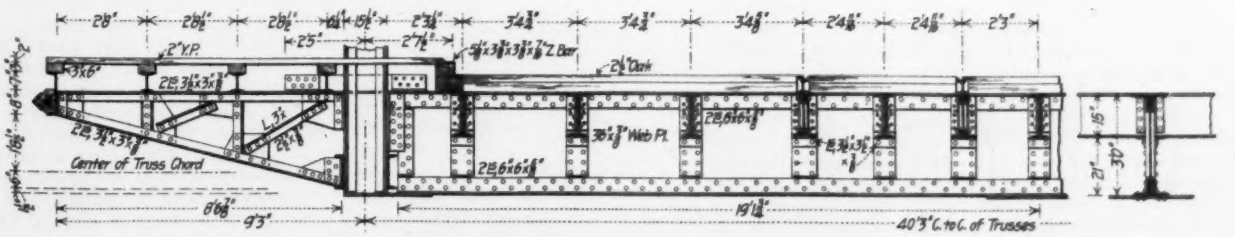


FIG. 4. FLOOR SYSTEM.

R THE CHICAGO RIVER AT ASHLAND AVE.

M. Hughes M. Am. Soc. C. E., Consulting Engineer.

CHAS. HART, LITH., 83 VESEY ST., N. Y.

nigher power, and they can hardly be called to account by the State for failure to draw from resources which they do not own, and which the State cannot give to them. The order of the Secretary of War is elastic to the extent that it imposes upon his local representative (the U. S. engineer in charge of the district in which Chicago is situated, the duty of carefully observing the effect of flow in the river, and advising from time to time the extent to which the order may be modified and the rate of flow increased.

The predicament in which the trustees of the Sanitary District find themselves does not end with this, however. Improved facilities for both sanitation and navigation must be provided in some way, but the present law prevents the trustees from undertaking the necessary works, since to do so would carry the district beyond its debt limit. Legislation is now pending in the Illinois State legislature, however, which will (among other provisions) grant to the district additional funds available for these purposes. The additional facilities may be provided in either one of two ways: First, by the widening, deepening, and general improvement of the river throughout; or, second, by the construction of new channels across the city from the lake to the river. The first method has already been studied in detail by the engineers of the Sanitary District and by a special commission on behalf of the city; and some advance information respecting the report of this commission was given in our issue of April 4, 1901. The official plan adopted by the Sanitary District calls for a river channel 200 ft. wide, with a depth of 16 ft. at the sides or docks, and a mid-channel depth of 26 ft. for a width of 100 ft. From this channel all center-pier bridges are to be removed and bascule bridges are to replace them. The estimate on the cost of this improvement, prepared by Mr. Randolph, Chief Engineer of the Sanitary District, is $9,024,000. The estimate of the expert commission above mentioned is $8,690,940, or nearly 3.69% less than the Chief Engineer's estimate. The accomplishment of this improvement, taken in conjunction with the completion of the 39th St. tunnel conduit (from the lake to the river) would, it is believed, amply meet the demands of the Sanitary District, and also afford for shipping interests a river greatly superior in its availability for navigation to anything the port of Chicago has ever yet known.

In regard to the second proposed method of improvement, open channels across the city would probably involve even larger expenditures than the improvement of the river on a large scale, as already noted. It would also have the great objection of cutting still another waterway across the city, making the business district an island. The channel would cross so many streets, railways and street railways that the expense of bridges or subways would be enormous, while the interference with traffic would be very serious.

In connection with the discussion of the economic value of stone-road construction in farming districts by Prof. I. O. Baker in this issue, it may not be amiss to note here that the proposed issue of $5,000,000 bonds by the State of New York to be expended on road construction has been abandoned. We do not say that such a sum would have been misspent. Our position is that to build hard roads on borrowed money is likely to encourage their construction in localities where the wealth and the traffic do not justify them. If a hard road once built would last for a long time with trifling expense for care and maintenance, there would be more reason in the attitude of those who would build "good roads" on borrowed money. But the cost of maintenance and renewal of such roads, especially in our severe northern climate, is such that no community ought to be saddled with the burden until its financial ability to carry it has been established. There is no better way of providing this than by letting each community pay for constructing the roads it is to use. Aid in such construction may be granted by the State, if deemed best, but such expenditures also ought to be provided for by taxation and not by borrowing money. There is no apparent reason why the taxpayers of New York are not as well able to endure taxation for such purposes at the present day as they will be a dozen years from now.

The promotion of Col. Henry M. Robert to the position of Chief of Engineers is a very proper recognition of the long and useful services of this distinguished engineer officer. By length of service and rank in the Corps, Col. Robert was entitled to promotion to this position four years ago; and, measured by the importance of his engineering achievements, he has fully earned this recognition. Both Gen. John M. Wilson, the present Chief of Engineers, and Col. Robert are now in the last year of their active army service, as Col. Robert will be 64 years of age on May 2, and Gen. Wilson will reach this age limit on Oct 7. Gen. Wilson volunteered to retire at once so that Col. Robert might be appointed, thus enabling him to retire with the rank and pay of a Brigadier-General. This action of the President will be commended by every engineer in the country, both military and civil. There are few situations in either public or private life where men carry such large resposibilities for so small a compensation as do the higher officers of the Corps of Engineers; and we may add that there are few departments of the public service where strict fidelity is so universal. Col. Robert has given his country 44 years of faithful service, and during the last dozen years especially he has held exceedingly onerous and responsible positions. His promotion is a reward abundantly merited.

The Pittsburg correspondent of the New York "Journal of Commerce" estimates the net profits of the United States Steel Corporation for the year 1900 on various classes of its products, and the figures are of some interest with reference to the oft-repeated claim that the company does not propose to exact exorbitant prices from consumers. In fact, in this identical article this claim is made as follows:

> It will be the policy of the big combine to keep prices of iron and steel as low as possible and give to the consumer in part at least the benefit of the low costs of production the combine will have through its ownership of everything used in making steel from the ore beds to the railroads and ships that will haul the finished stuff to the markets of the world.

Further on the correspondent gives some practical examples of the "low prices" by which the consumer is to benefit. In steel rails, for example, he estimates the year's output of the mills in the U. S. Steel Corporation at 1,250,000 tons, and says:

> There ought to be a profit at the present price of $26 of $10 a ton on every ton of rails they turn out. This would mean a profit this year on rails of at least $12,500,000, and it may run more than that.

Next he turns to armor plate. Who doesn't remember the plentiful assurances that the armor plate making companies were losing money on their government contracts, and only accepted Secretary Long's offer of $425 a ton a few months ago out of pure patriotism! This is the way the armor plate contract looks now:

> The armor plate mills of the Homestead Steel Works got an order some months since for about 6,000 tons of armor plate for the government at $425 a ton. It would hardly be safe to guess at the amount of profit per ton this price will pay, but to put it at $100 a ton will be very conservative, and it may be double that.

Tin plate is the next product taken up, and at the present standard price of $4 a box the average profit is estimated at $1.50 per box. With a prospective output in 1901 of 8,000,000 boxes, this means $12,000,000 profits for the year.

In the light of profits such as these, the public is likely to form its own opinion concerning the alleged benevolent position of the combine toward consumers.

A scheme which will prevent neglect of municipal work and waste of municipal funds in cities which suffer under political mismanagement is hard to devise and harder to introduce; but something of the sort seems to have been done in Chicago. The English comic paper "Punch," many years ago, suggested as a means of preventing railway collisions that a director should be tied to the buffer beam of each locomotive. In Chicago, the plan is to make an alderman the buffer. The filthy condition of Chicago streets and alleys is well known, and few citizens now trouble to make complaints to the street cleaning department, knowing that it is useless. Recently, however, a citizen appeared at the office of the street cleaning bureau, in the City Hall, and complained regarding the piles of refuse and the overflowing garbage boxes in a certain ward. After receiving more or less rebuffs and insolence from various subordinates, as he continued to insist upon the matter being taken up, the superintendent of the bureau appeared in person and advised the importunate complainant to "go throw himself into the lake," presumably that he might cease from being troubled by dirty streets and from troubling the officials responsible for the conditions. The complaining citizen, however, happened to be an alderman, and instead of adopting the cooling treatment advised by the superintendent, he proceeded to set on foot an investigation which has given the street cleaning bureau a thorough shaking up. It developed that work had been neglected in many wards, although pay rolls for the work were large and continuous. Several men have been discharged, others have been transferred to new districts, and the officials in charge have received some sharp reprimands. Many of the aldermen are now acting as amateur superintendents of street cleaning, and by keeping account of the pay rolls and the street gangs in their respective wards they are making things lively for the men who have been enjoying sinecures "on a broom."

The New York legislature, just before its adjournment, on April 23, passed a bill granting to the New York & New Jersey Bridge Co. a franchise to build an elevated railroad on West St., in New York city. The ostensible purpose of this elevated railroad is to form a terminal for the proposed bridge across the Hudson River at 60th St. The company has held a franchise for more than ten years for the construction of this bridge, but it has never done anything in the way of actual construction or given any evidence of the necesssary financial ability.

New York city has spent millions of dollars in the widening and improvement of West St. For the legislature to give away a franchise for an elevated railway here to a corporation which has been refused this very franchise by the city authorities because it would not give the city a fair rate of compensation, is a crime against good government. The party leader who forced the bill through the Assembly attempted to wash his own hands of responsibilty by declaring that the Governor had 30 days to find out whether the bill was good or bad, and he would trust the Governor to sign it or veto it, according to its character. Under these circumstances, Gov. Odell should have no hesitation in affixing his veto to the measure.

New York city has not forgotten how past franchise gifts by the legislature have depleted the city treasury, and the party on whom the responsibility for further gifts of this sort can be placed will be made to suffer at the polls.

THE DESIGN OF LOCOMOTIVE THROTTLE-VALVES.

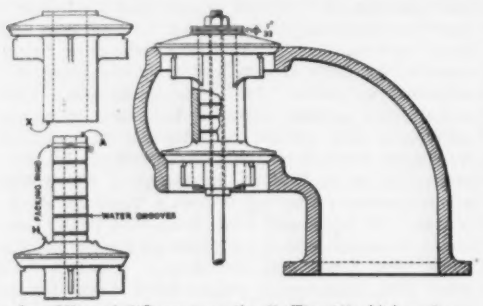
Several weeks ago there was published in a number of journals devoted to railway interests an illustrated description of a "compensating" throttle-valve, invented by Mr. J. S. Chambers, Division Master Mechanic of the Central Railroad of New Jersey. The object of this invention was to make a double-poppet valve which would keep tight and not leak, as the ordinary throttle-valve is more or less apt to do. This is a puzzle over which a good many inventors have racked their brains, and if Mr. Chambers has solved the problem, the fact is of considerable importance.

For this reason we read the description and studied the drawings of the device which appeared in various esteemed contemporaries with a good deal of care. They all read very nicely, indeed, until one reached the explanation of the principle on which the device operated, and here they gave "an explanation that didn't explain."

In justice to one of our contemporaries, how-

ever, we should say here that the editor of "The Railroad Digest" appears to have had some difficulty in accepting the inventor's explanation of the working of his device. In recognition of his mechanical conscientiousness we reproduce his description of the device, together with the accompanying illustration, as follows:

Mr. Chambers' valve, as illustrated, is clear enough as far as construction is concerned and simple enough also, for that matter. The valve consists of two parts, the stem of the lower disk fitting inside the enveloping stem of the upper disk, the former having a series of water grooves



An Alleged "Compensating" Throttle-Valve for Locomotives.

cut in it, at regular intervals, and a packing ring is used instead of the top groove. When put together the two disks are capable of approaching toward, or receding from, each other through 1-32-in. The valve is, therefore, capable of adjusting itself, or of compensating, as the inventor puts it, for any slight increase or shrinkage in the throttle case.

To explain a little more in detail for the benefit of readers who may not be familiar with locomotive details, we may note that in ordinary throttle-valve construction, the valve is cast in one piece. The steam pressure, when the valve is closed, tends to force the upper disk of the valve against its seat and to lift the lower disk off its seat. Since the upper disk is a little larger in area than the lower disk, the valve tends to close itself. Evidently, if the two disks are exactly as far apart as the two seats against which they rest, the valve will be tight; but the most infinitesimal difference will cause one disk to reach its seat before the other and leakage will result.

Now, let us turn to Mr. Chambers' device. He makes his valve in two parts, with a steam-tight joint between, and he so connects them that the two parts have 1-32-in. play, as stated above. Suppose we have an 8-in. diameter throttle valve, working with steam at 200 lbs. pressure. Then each disk of the valve, when closed, will have a load of about 10,000 lbs. upon it. Now, if Mr. Chambers' valve is subjected to this pressure, and its two disks are free to approach each other by 1-32-in., it looks as if when the upper disk were seated, the lower disk would be raised 1-32-in. from its seat.

Note how the editor of "The Railroad Digest" wrestles with this difficulty:

How this adjustment takes place is not quite so clear. It is evident that the upper disk is held down tightly on its seat by the pressure of the steam, but what prevents the lower disk from rising up off its seat in obedience to the same pressure? The explanation given is that the pressure of the steam forces the water of condensation down past the water grooves, and that this film works its way between the faces at X and H and so keeps the lower disk tight, on its seat.

There is, however, one feature of the construction which should not be overlooked. The washer and nut which secures the bolt which passes up through the center of the valve, rests directly upon the upper surface of the stem of the lower disk, marked A in the sketch. In seating, the lower disk is brought to its place by the throttle mechanism, which locks on the outside of the boiler, and if expansion of the thfottle-case has taken place, the upper disk is caught upon its seat, while the lower one is "placed," in the act of closing the valve. The two disks have then the greatest separation which expansion can give, though it is relatively very small indeed. The lower disk has its own weight plus the weights of bolt, nut, washer and part of the throttle-crank to help hold it down, but this combination of mere weight would be insignificant against the upward effort of the steam. Mr. Chambers' experiments prove that it is not the locking or latching of the throttle handle outside the boiler which holds the lower disk in its place, as he made one test with the throttle lever loosened from the ratchet with most satisfactory results. After the throttle-valve has been closed, and the lower disk "placed" by the throttle mechanism, the disk apparently shows no disposition to rise. A possible explanation of this is that when the throttle is open and the valve is enveloped in the powerful rush of hot steam into the dry pipe, that the water film is evaporated or drawn away, and that consequently the upper disk sinks down upon the lower, only to be caught again upon its seat in the act of closing the throttle, while the lower disk is carried to its position, and that the almost instantaneous reappearance of the water film in the closed case secures the lower disk in the continued and necessary tight contact with its seat, which renders this invention a satisfactory and valuable device.

We have striven to understand how a "water film" can keep a valve to its seat against a pressure of some five tons; but it is too much for our comprehension. Capillary attraction, we may grant for the sake of argument, might increase the distance apart of the two disks of the valve by an infinitesimal amount, if condensed water finds its way between the abutting surfaces of the two parts of Mr. Chambers' valve; but such capillary attraction would be a practically constant force, and how it could cause the valve to adjust itself to changes in the distance apart of the valve seats is far from evident.

It appears to us that the operation of Mr. Chambers' valve can be explained in a much simpler way. In fitting an ordinary throttle-valve it is ground to its seats with emery. Mr. Chambers' valve is doubtless put together and ground to its seats in the same way. In this condition it will be, there is every reason to suppose, as tight as any ordinary throttle-valve; and, as nine out of ten ordinary valves give no particular trouble from leakage when once they are fitted, the chances are good that Mr. Chambers' valve gives none. The verdict of the stranger who bet against the famous jumping frog of Calaveras in Mark Twain's story, was that "he didn't see no pints about that 'ere frog that was any better than any other frog." A similar opinion seems applicable to the device above illustrated. In other words, Mr. Chambers' valve can doubtless be made as tight as a common throttle-valve; but that it will be any less liable to leakage, or that it has any "compensating" action to meet changes in the pipe to which it is fitted, is yet to be proved.

And now, since we are on the subject of throttle-valves, it may be worth while to discuss still farther the difficulties with them and the points to be considered in their design. The double-poppet or balanced throttle is a typically American detail of locomotive construction. Foreign locomotives are almost invariably fitted with slide-valve throttles. We believe that fault has been recently found with some American locomotives exported to foreign countries because of the throttle-valves. The repair shop forces being accustomed only to slide-valve throttles did not know how to grind an American throttle-valve tight when it became leaky.

Concerning the fitting of throttle-valves, Meyer's treatise on "Modern Locomotive Construction" has the following:

Throttle pipes are always made of cast-iron, and therefore the throttle-valves should also be made of the same metal, so as to obtain an equal rate of expansion in the valve and the pipe, thereby preventing leakage. It is on account of the difference in the rate of expansion of the different metals that brass valves in cast-iron pipes have proved to be a failure. Even cast-iron valves will expand lengthways a trifle more than the pipe, and this fact should not be overlooked in fitting the valve to its seat. In order to obtain a steam-tight joint, the valve is ground on its seats, until a perfect fit between both the upper and lower disks and their seats has been obtained; the emery should then be wiped off the upper disk and its seat, and a few extra turns given to the valve, so as to very slightly ease the fit between its lower disk and seat; fitting the valve in this manner will generally secure a steam-tight throttle when the engine is under steam.

It appears to us that, in considering the causes of throttle-valve leakage, not only temperature changes, but the action of the steam pressure must be considered. The valve can be ground to fit its seats so as to be perfectly tight when cold and when subjected to only slight pressure. What conditions must be observed to ensure that it shall be also tight when subjected to the steam pressures of locomotive service? So far as the temperature change is concerned, there is no apparent reason why the valve and its case should not expand and contract alike. The same cannot be said, however, of the steam pressure effects. The valve, for example, may have a pressure approaching five tons on the two opposite disks, and the valve, having a height of perhaps 7 or 8 ins., it is apparent that a shortening of the stem which joins the disks must result from such a compression. But the case in which the valve moves is also subject to compression when the valve is closed, and if the seats are made to approach each other by the same amount as the disks, the valve will still remain tight. The valve and its case, however, are so dissimilar in shape that an equal yielding under the pressure is by no means certain. Is not here the most probable cause of trouble from leaky throttle-valves?

An approximate computation of the compression of an ordinary throttle-valve under 200 lbs. steam pressure, showed that the two disks might from this cause be brought toward each other by nearly 1-1000-in. Manifestly, if a similar change in the position of the seats did not take place through compression of the valve case, leakage would result.

The practical lesson to be drawn from the above discussion, if our statement of the case be accepted, is that the designer of throttle-valves should bear in mind the elastic deformations to which the structure is to be subjected. It is quite possible, for example, that with the very large throttles applied to recent locomotives, leakage may be caused from distortion of the throttle case and the valve seats when subjected to steam pressure. Heavier sections in both the valve and its case will diminish the chances of this, will reduce the yielding of the whole under compression, and will give castings of more uniform structure, less likely to carry internal strains and to warp under temperature changes.

LETTERS TO THE EDITOR.

"Plunging a Grade."

Sir: In reply to the query of J. O. E., in your issue of April 18, 1901, concerning a "plunge rod" and the operation of "plunging a grade," I would state that this operation is a short and accurate method of establishing points on the grade line, between two extreme grade points by means of a simple mechanical method, and without calculation of the grade elevation for the points to be established. The method of plunging a grade is as follows: Grade points are established in the ordinary manner by means of level and necessary calculations, at the extreme ends of the line for which the grades are to be given, or at convenient intermediate points, which can be accurately observed from the instrument. The transit or level, preferably a transit with vertical arc or level attachment, is then set up over one of these points and the level rod placed on the grade point, measuring directly the distance from the grade point to the height of instrument. The target of the level rod is set at the distance found; and I might state, that this height may be more accurately found by direct leveling from some convenient "turning point" after the transit has been placed in position. The level rod, with target clamped at the proper height, is then placed on the next grade plug established; the instrument is then turned on the rod so that the horizontal cross-hair intersects the target and all clamps of the instrument tightened, so that the cross-hairs are in a direct inclined plane, or "plunged" in the direction of the grade. By moving the rod to any desired intermediate point, and once more intersecting the target with the horizontal cross-hair, the base of the rod will be at the desired grade elevation.

This method of plunging grades is decidedly rapid and sufficiently accurate for ordinary work. It saves much calculation, and frequently avoids serious errors. It has been used by the writer in municipal work to great advantage and has been found useful in many classes of engineering work. Yours very truly,

John McNeal, Jr., Civil Engineer.

Easton, Pa., April 19, 1901

(Another letter has been received from an engineer in New York city, describing the same process in almost identical terms.—Ed.)

The Relations Between the U. S. Steel Corporation and Its Employees.

Sir: Your article concerning the relations between the U. S. Steel Corporation and its employees is timely and rather searching withal, and it brings to the surface the counterpoise provided by nature for offsetting the apparently extreme power of capital in the growth of legitimate enterprises to greater and greater proportions. Although there seem to be immense advantages upon the side of the so-called trusts in the matter of power and endurance, the touchstone of "management" furnishes the test for success or failure in the final outcome.

The politicians endeavor to frighten the "workingman" with horrible nightmares of bloated corporations, but there is really much more danger to the corporation than to the workingman; and it will be found that there are many more sudden deaths from heart failure and nervous wreck among the managers of large establishments than among the so-called toilers for daily bread. It is rather a ghastly joke to exclude the overloaded long-houred managers of a large business from the ranks of workingmen.

Actual mastery of details and real knowledge of the business is necessary for success, and these qualities are not too frequently found among those whose stockholding

powers give them a legal right at the front. But they have credit on their side as well; for few have the ability to get and keep a million dollars.

A man who enters any line of business or industry when young, and grows grey and experienced before he drops out, has secured a hold upon his work which nothing can displace or replace excepting some more of the same thing; and when this man joins commercial instincts with technical ability, a combination is the result which shows to the world the giant man, who is a match for the giant corporation. It is the infrequency of this combination which makes the giant corporation dangerous. The bigger the trust, the bigger the fixed charges, and the bigger must be its market; but at the same time the smaller in proportion is its directing power, the greater the risks in judgment. The man who can stay at the head of a hundred million dollar corporation and ably direct its operations deserves all he receives, and there are few who can do this.

As to wages and salaries of employees, the laws of nature put into commercial form dictate that only a dollar's worth can be had for a dollar, and it is the manager's business to know when he is paying fifty cents and looking for a dollar's worth of goods; if he ever does make such a blunder, it is best for him to find it out quickly for the good of the concern.

This may not be much like engineering, but engineering establishments are involved.

Yours respectfully, Chas. A. Hague.

39 Cortlandt St., New York city, April 16, 1901.

The Economic Value of Hard Roads.

Sir: Will you permit me space for a brief reply to Mr. H. P. Gillette's communication on the above subject in your issue of April 11? Your comments following the communication completely answer the fundamental principles involved, but I desire to call attention to a few of the details of Mr. Gillette's argument.

Gardeners, dairymen, etc., constitute one fifty-seventh of the so-called farming class, but they produce a far smaller proportion of the highway traffic, even though the gardeners produce more per acre, since the farmer proper cultivates a vastly larger area. As you say, Mr. Gillette has in mind the market gardener chiefly; and I agree with most of what he says in that connection. I desire to consider only the case of the average farmer.

I grant that it is not mathematically correct to charge all of the cost of maintaining the team, to raising the crop; but the error is not material. Statistics from 316 Illinois farmers in 76 counties show that it requires 8¾% as much time to market the oat and corn crops as to raise them. As a considerable part (usually the great bulk) of the crop is marketed during the slack season, the value of the time is less than during the busy season. The actual time consumed in marketing the crops is only one-third of that claimed by Mr. Gillette. Of course I am referring to Illinois, but all my articles on road economics have referred to Illinois—either by direct statement, or distinct implication. Advocates of hard roads ought not to object to this use of Illinois—a state conspicuous for its large crops and "bad" roads.

Mr. Gillette says I have given "little or no thought to the weight of different crops produced per acre of land." He claims that wheat will produce 1 ton, or say 36 bushels per acre; the statistics of Illinois show the average is between 12 and 13 bushels. Mr. Gillette claims corn will produce 2 tons, or say 72 bushels per acre; the statistics of Illinois show the average to be 32 bushels—and Illinois is noted as a "corn state!" Mr. Gillette claims that potatoes will produce 8 tons, or nearly 300 bushels per acre; the statistics of Illinois show that the average is 83 bushels. These are the first three items in Mr. Gillette's table, and each is about 3 times larger than the average for Illinois, and Illinois is at least as productive as the average state.

Mr. Gillette assumes that a 160-acre farm will send 200 tons to market per annum, or 1¼ tons per acre. In the Illinois corn belt, where there is absolutely no waste land, on a farm of 160 acres there will not be more than 110 to 120 in cultivation. For convenience we will assume the larger quantity; and then we may say that three-fourths of each acre is in cultivation. If it is in corn, which in two senses is Illinois's heaviest crop, the average production being 32 bushels, the product per acre will be $\frac{3}{4} \times 32 \times 56 \div 2{,}000 = 0.67$ tons. Statisticians estimate that from one-third to four-tenths of the crop is used on the farm, but to be on the safe side, I will use the smaller value. Therefore the produce to be marketed is $0.67 \times \frac{2}{3} = 0.44$ tons per acre per annum, or about one-third of that assumed by Mr. Gillette.

Mr. Gillette computes the actual cost of team and driver "even during a dull season to be slightly less than $3 per day." The cost during the crop season as reported by 316 Illinois farmers in 76 counties varies from $1.40 to $2.74, the average being $2.13 (Engineering News, Jan. 31, 1901, p. 86, 3d column). This is seven-tenths of Mr. Gillette's estimate. If this is the farmer's estimate of the cost during the busy crop season, what would be his estimate for the idle season?

Mr. Gillette estimates that with earth roads one-third of the time is necessarily spent in idleness on account of winter weather and 10% of the remainder is lost by rainy days—a total loss of 40%. As I read that statement I looked out of my study window and saw a teamster unloading cinders on a neighbor's driveway. I went across the street and learned that he had lost not more than 30 days in that time by bad weather and bad roads—a loss of 2 per cent. I may say that Illinois roads are as bad as any, and the amount of pavement in the town is too small to materially affect the matter. Doubtless this case is extreme, as is also Mr. Gillette's assumption. Since the average farmer requires only a comparatively small amount of time to market his products, bad weather and temporarily bad roads have but little to do with the problem.

Mr. Gillette states that 15 cts. per ton mile is the least he will concede as the cost of hauling non-perishable farm products on earth roads. The current price all over Central Illinois during the busy crop season is about two-thirds of this amount; and during the idle season hauling is done for about half of Mr. G.'s estimate. Note that these are prices that have actually obtained over a large part of the state of Illinois for 10 or 15 years, and do not refer to "a few isolated cases," nor "to farmers who do their own work." Note further that Illinois roads are conspicuously "bad." Farther, frequently the cost is even less than the least price stated above, since a man will often drive two teams and haul two loads, and since a very small boy sometimes drives the team.

Mr. Gillette figures out an annual saving by hard roads of $320 per mile of road. I think his estimate is at least six times too large for the reasons stated above; but let us see what $320 per mile will do. Mr. Gillette says: "This sum is sufficient to pay interest on first cost and to maintain an excellent paved road." On pages 159-65 of the Report of the Massachusetts Highway Commission for 1900 is a statement of the amounts expended for repairs and maintenance. The cost of maintenance ran as high as $824 per mile per annum, 10% being over $200 and the average being $105 per mile per annum. None of these roads are over five years old. No data are given by which to determine the cost of maintenance for the different ages. Of course the cost of repairs will increase with the age of the road. The report says (page 31): "No serious damage has been caused by floods or freshets. The amount expended in maintenance has been caused for the most part by cleaning gutters and shoulders, and the placing of binding material upon roads traveled mostly by light vehicles and upon roads where the binder is removed by the wind faster than the wear of the stone supplies it." Subtracting $105 (the cost of maintaining the Massachusetts roads) from $320 leaves $215 as the interest upon the first cost. At 5% this will permit an expenditure of $4,300 per mile for construction. The Massachusetts roads built previous to 1896 "cost about $9,000 per mile" (Shaler's American Highways, p. 213).

If Mr. Gillette's original "saving" of $320 were scaled down to correct for his own estimate of the amount of produce, the "saving" would be $107—an amount just equal to the average annual cost of maintaining Massachusetts roads during the first five years of their life. And if we were to correct his "saving" to compensate for his over estimate of the cost of transportation, we would have a sum insufficient to pay for maintaining the road during the first five years of its life, with no provision for the interest on first cost.

As I had nearly completed this article, an unusually intelligent and successful farmer, a man who in several ways has had a large influence in the agricultural development of the state, called upon me and read Mr. Gillette's communication. My friend read my reply as above, and said I had not even referred to the farmer's most serious objection to Mr. G.'s article. He said that an important part of the farmer's business was raising horses, and that Mr. G.'s point about draft horses trotting on stone roads would be ruinous to that branch of the farmer's business. He claimed farther that there should be no "allowance for interest and depreciation" on the farmer's teams. My friend supported his views by apparently sound arguments, but which it would be unwise to attempt to reproduce here. I believe that he understands farming as well as any other man understands his own business.

In conclusion permit me to refer to a phase of the question only briefly considered by Mr. Gillette. He says that in a particular township of which he knows land has increased in price $9 per acre due to the construction of good roads. Great care is necessary in using this kind of evidence. In the last 10 years there has been a remarkable rise in the price of agricultural land all over the country, and it is very difficult to differentiate causes. I know of a township in which purely agricultural land increased in price $30 per acre (50%) in the past 10 years, and there is not a foot of hard road in the township! Again, the building of a hard road frequently changes agricultural land into suburban property, with a marked rise in the price, but that phase of the subject is not now under discussion. Ira O. Baker.

University of Illinois, April 16, 1901.

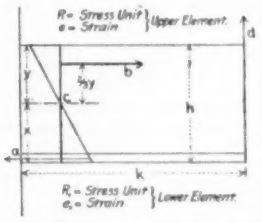
Computing the Strength of Concrete-Steel Beams.

Sir: The remarkable progress of concrete-steel construction induces me to send you herewith a simple mathematical discussion on beams built of these materials. The discussion leads to certain working formulae which may be useful to others as they have been to me. No pretense is made that any originality exists in the theory adopted—nor that the assumptions made are always strictly in accordance with physical laws.

The fundamental equations derived from the assumed theory are numbered with Arabic numerals. The working equations deduced from above by assuming values for moduli of elasticity, etc., are numbered with Roman numerals.

If the equations be used it should be remembered that they relate to beams 1 in. broad. The necessary corrections should be applied for beams in practice. If any one thinks my values of M_c, M_s, R', and R, are ill-chosen, he can readily substitute others.

It will be observed that, if I have followed a working theory, a concrete-steel beam should have the sectional area of steel, which is concentrated near the lower element to take up the tension, about 1% of the sectional area of the beam as a whole (see [IV.]).



Assume a beam fixed at one end and strained by a force d:

k = length of beam;
h = depth of beam;
1" = breadth of beam.

The lower elements are of steel, and the rest of concrete. In calculating moments, assume that the concrete below the neutral axis does not resist by tension, and that the lever arm of the stress in the steel is the distance from the neutral axis to the bottom of the beam.

R = unit stress in upper element of concrete (compression);
R' = unit stress in steel (tension);
M_c = modulus of elasticity of concrete (assumed to be 750,000 lbs.);
M_s = modulus of elasticity of steel (assumed to be 30,000,000 lbs.);
A = area of steel in cross-section (= thickness, since beam is 1 in. broad);
b = stress due to compression of concrete; as the stresses vary uniformly from neutral axis to top of beam; the lever-arm of this force = ⅔ distance from neutral axis to top of beam;
a = stress on total area of steel;
e = strain (diminution in length of unit length) of upper element of concrete;
e' = strain (increase in length of unit length) of steel;
x = distance, lower element to neutral axis;
y = distance, neutral axis to upper element;
MR = resisting moment due to stresses in concrete and steel;
MB = bending moment due to extraneous forces.

The forces a and b are equal in amount, since there is no horizontal motion;

$$\text{but } a = R' A, \text{ and } b = \left(\frac{R+0}{2}\right) y$$

average stress along y, multiplied by y,

$$\therefore R' A = \frac{R y}{2}. \qquad (1)$$

By definition of modulus of elasticity

$$\frac{R}{e} = M_c; \qquad (2)$$

$$\frac{R'}{e'} = M_s. \qquad (3)$$

And by similarity of triangles, $x : e' :: y : e$,

$$\therefore x e = y e'. \qquad (4)$$

MR = b into its lever arm, $\frac{2y}{3}$, + a into its lever arm, x; $\therefore$

$$MR = \frac{R y^2}{3} + A R' x. \qquad (5)$$

MB = the straining force into its lever arm,

$$\therefore MB = d k. \qquad (6)$$

Now, for practical purposes, we wish a beam which will break at concrete and steel sides at same time, i.e., a beam of uniform resistance.

To apply the elementary equations written above, and to deduce useful formulae from them, it is necessary to choose limiting values for R and R', as determined by experiment.

Let us assume R at its limit = 500 lbs.; and R' at its limit = 16,000 lbs. We have already assumed $M_c = 750{,}000$ and $M_s = 30{,}000{,}000$.

[A.] Having given area of steel, to find depth of beam of uniform resistance:

From (1), $16{,}000\ A = \frac{500\ y}{2}$, $\therefore\ y = 64\ A$. [I.]

From (2), $e = \frac{R}{M_c} = \frac{500}{750{,}000} = \frac{1}{1{,}500}$.

From (3), $e' = \frac{R'}{M_s} = \frac{16{,}000}{30{,}000{,}000} = \frac{1}{1{,}875}$

$$\therefore\ \frac{e'}{e} = \frac{1{,}500}{1{,}875} = 0.8$$

From (4), $\frac{e'}{e} = \frac{x}{y}$

$$\therefore\ \frac{x}{y} = .8, \text{ or } x = .8\ y. \quad [II.]$$

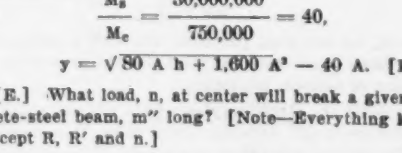
but

$$y = 64\ A,\ \therefore\ x = 51.2\ A. \quad [III.]$$
$$x + y = h,\ \therefore\ h = 115.2\ A. \quad [IV.]$$

[B.] Conversely if h (depth of beam) be given, in order to make beam of uniform resistance, the steel must be so chosen that

$$A = \frac{h}{115.2}. \quad [V.]$$

[C.] Having given load and span, to design a beam of uniform resistance



let n = load at center; m = length of beam in inches, supported, but not fixed, at both ends.

$$MB = \frac{m}{2} \times \frac{n}{2} = \frac{m\ n}{4}.$$

From (5), $MR = \frac{500\ y^3}{3} + 16{,}000\ A\ x$;

equating above, we have

$$\frac{m\ n}{4} = \frac{500\ y^3}{3} + A\ (\times)\ 16{,}000;$$

and from [II.] and [III.]

$$x = 0.8\ y, \quad A = \frac{x}{51.2}.$$

Solving these three equations for x, A and y, we have:

$$y = \frac{\sqrt{m\ n}}{38}. \quad [VI.]$$

$$x = \frac{\sqrt{m\ n}}{48}. \quad [VII.]$$

$$A = \frac{\sqrt{m\ n}}{2{,}400}. \quad [VIII.]$$

[D.] Having given A and h, to find position of neutral axis:

From (4), (4) $y = x\ \frac{e}{e'}$;

but,

(3), $e' = \frac{R'}{M_s}$ and (2), $e = \frac{R}{M_c}$, $\therefore\ y = x\ \left(\frac{R}{R'}\right)\ \left(\frac{M_s}{M_c}\right)$

now

From (1), $\frac{R}{R'} = \frac{2\ A}{y}$, $\therefore\ y = x\ \left(\frac{2\ A}{y}\ \frac{M_s}{M_c}\right)$;

or $y^2 = x\ (2\ A)\ \frac{M_s}{M_c}$, $\therefore\ y = \sqrt{x\ (2\ A)\ \frac{(M_s)}{(M_c)}}$,

and, from the data assumed, $x = h - y$; two equations to be solved for y (or x).

Asauming

$$\frac{M_s}{M_c} = \frac{30{,}000{,}000}{750{,}000} = 40,$$

$$y = \sqrt{80\ A\ h + 1{,}600\ A^2} - 40\ A. \quad [IX.]$$

[E.] What load, n, at center will break a given concrete-steel beam, m″ long? [Note—Everything known except R, R′ and n.]

From (5) and (6) $\frac{n\ m}{4} = \frac{R\ y^3}{3} + A\ R'\ x$;

From (1) $R = \frac{2\ A}{y}\ (R')$, or $R' = \frac{R\ y}{2\ A}$,

$$\therefore\ \frac{n\ m}{4} = \frac{2\ A\ R'\ y}{3} + A\ R'\ x; \quad [X.]$$

$$\text{or } \frac{n\ m}{4} = \frac{R\ y^2}{3} + \frac{R\ x\ y}{2}. \quad [XI.]$$

Place R′ = 16,000 in [X.] and place R = 500 in [XI.]; solve for n m each case and choose the smaller one.

W. V. J., M. Am. Soc. C. E.

Montgomery, Ala., April 1, 1901.

(Previous discussions of the transverse strength of concrete and steel in combination have appeared in Engineering News, Vol. July-Dec., '94, pp. 387, 516; vol. Jan.-June, 95, pp. 10, 58.—Ed.)

Note-Book Sketching in Stadia Surveys When Platting is Not Done in the Field.

Sir: To make a topographical sketch only approximately to scale seems to be difficult to most men and almost impossible to a good many. If every change of direction in lines and slopes were located, sketching to scale would be unnecessary; but in stadia surveying this is rarely the case, and a great deal of sketching has to be done for which the located points must serve as a guide. This sketching, to be of the proper value in making the map, should be as nearly to scale as possible, which can only be accomplished when all guiding points are put down accordingly. To attain this, I propose a note book ruled with lines radiating from the center of the page for locating azimuths, and concentric circles for locating distances; all properly numbered, as in the accompanying cut.

The recorder, after noting down on the left-hand page the azimuth, distance, vertical angle, etc., may upon the right-hand page, lined in this manner, mark down the point to scale without any mental effort. If a stadia slide rule is used, he will have plenty of time to add the elevation, where required, and thus have a skeleton prepared upon which the topographer may sketch with facility.

Very respectfully, Rich. G. Doerfling.

411 P. O. Building, Pittsburg, Pa., Oct. 29, 1900.

(Our correspondent's scheme for a stadia field-book seems to us a very excellent one; so much so that if sufficient interest is manifested by our readers, we propose to prepare such a book for sale. Before undertaking this, however, we shall be pleased to have the criticisms of our readers on the proposed ruling as here presented for both the sketch page and the page facing for the field-notes. It will be understood, of course, that in the preparation of the book, both the page ruling on the note page and the circles and radial lines on the sketch page will be printed in light blue or pink, and not in black, which is necessary in the present cut.—Ed.)

№	Object	Azimuth	Distance read	Distance corr.	Vertical Angle	Height	Elevation
1	Sounding Stake	155°-11′	1980				
2	" "	136-58	1760				
3	" "	119-42	1650				
4	Upstream House Cor.	122-16	1870				
5	Downstream " "	111-58	1820			-1	703
	etc						
17	Sounding Stake	136-45	1290				
18	" "	162-03	1180		-0° 25′	-29	675
	etc						
32	Foot of Hill	196-12	1960		+0° 08′	+5	709
33	Top "	214-03	1990	1970	+2° 18′	+80	784
	etc						

PROPOSED RULING FOR LEFT-HAND PAGE OF STADIA FIELD-BOOK.
(Ruling to be printed in light blue.)

Notes and Queries.

Our attention has been called to a possible wrong impression conveyed by a portion of the article in our issue of April 11, on "The Asphalt Plant at Winnipeg, Manitoba." It is said that our reference to the table on the cost of asphalt pavements in 47 cities, in 1900, published in our issue of Feb. 21, 1901, conveys the idea that the cost of grading was omitted from the Winnipeg figures, but included in the others. The correct statement is that that item was omitted from the figures for all the cities.

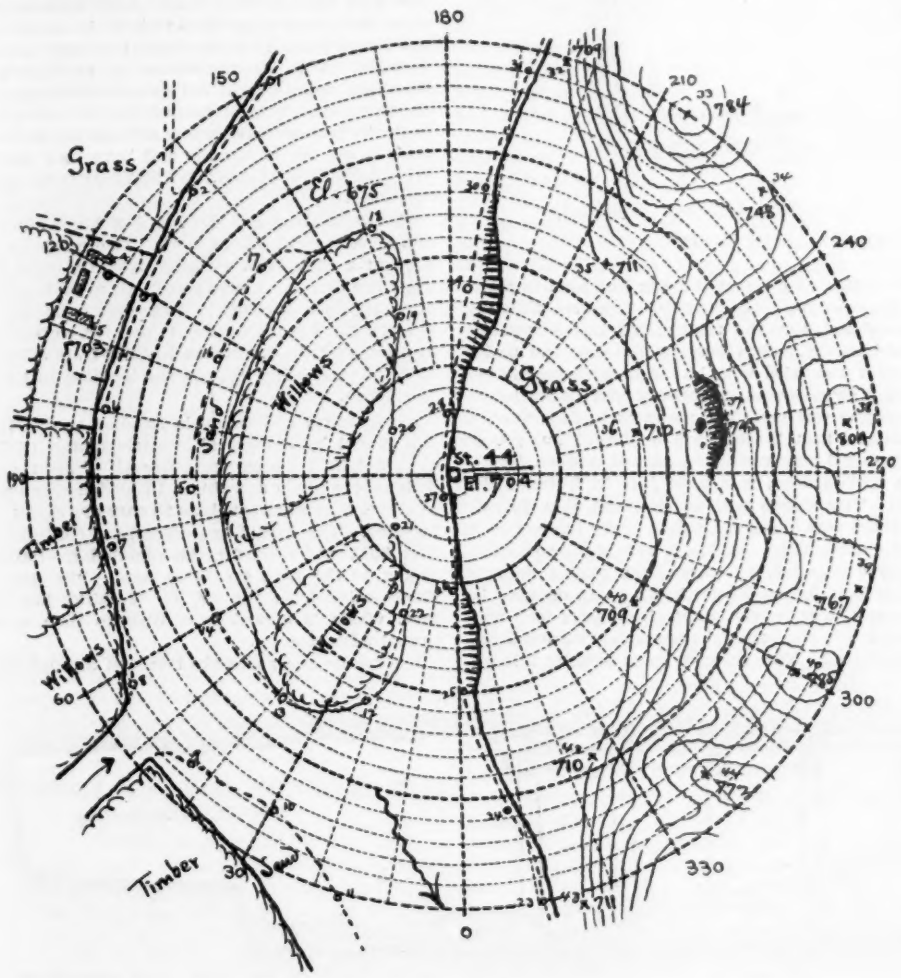
A DREDGING TRUST is said to be in process of formation, under the leadership of J. A. Smith, of L. P. & J. A. Smith, of Cleveland, O. The attempt is being made to consolidate the dredging interests of the principal Lake ports, under the plea that competition is ruining the business on the Great Lakes.

PISTON VALVES are very extensively used on compound locomotives, and have also been applied to a number of modern simple engines carrying high boiler pressures. Perhaps their most extensive use on simple engines has been on the Chicago, Burlington & Quincy R. R., for we learn officially that they have been used exclusively on all engines built for that road during the past two years. They are being applied to all the new Prairie type freight engines—60 in number—now being built for this company at its own shops and by the Baldwin Locomotive Works. These are simple engines, with cylinders 20 × 24 ins., and carry a boiler pressure of 200 lbs. Many engineers, however, disapprove of the use of these valves on simple engines, and in the course of a lecture recently delivered by Mr. S. M. Vauclain, of the Baldwin Locomotive Works, before the New England Railway Club, he expressed his opinion quite strongly in favor of the use of piston valves for compounds and his opposition to their use for simple engines. We quote his remarks as follows;

In regard to the piston valve as used in the locomotive, I desire to say that in our four-cylinder compound we find that it is necessary for us to use a piston valve. The piston valve was objected to by many. It was one of the principal things on the engine that it was thought would condemn it, and would prove a source of weakness in its design. The object of using the piston valve was to combine two valves in one, and at the same time provide a receiver for the high-pressure cylinder to temporarily exhaust into before the low-pressure engine was ready to receive its charge of steam. The use of piston valves on the simple engine is quite a different matter, however, and I have so far in my experience failed to see the necessity of using piston valves on a simple or single expansion locomotive. The piston valve on a single expansion locomotive, whilst it may have some advantages, has disadvantages. The balance of favor, however, from my observation and from my point of view still rests with the slide-valve, if properly designed. The piston valve is said to operate more steadily and easily, but I fail to see it, provided the slide-valve is properly adjusted. There is a serious source of inconvenience in the use of the piston valve, as it seals the cylinder at a time when the engine may be working water, thus causing damage to the cylinder heads, the water not being able to escape. We have met with this difficulty in compound locomotives where we have been compelled to use the piston valve, and we have provided means for overcoming it; that is to relieve the cylinder of excessive pressure that would be caused by the entrapped water. With the single expansion locomotive in introducing piston valves we have introduced something that will require the introduction of something else to avoid an accident.

FEATHERING PROPELLERS for use on sailing vessels, equipped with auxiliary steam power, were invented by the late R. R. Bevis, of the famous ship-building firm of Laird Bros., Birkenhead, England, according to an account in London "Engineering." They were so designed that the blades of the propeller could be set in a fore and aft position when it was desired to stop the steam machinery and propel the vessel by wind alone. For many years they were extensively used on naval and merchant vessels, and are still in use on yachts and pleasure boats. With the recent increase in the price of coal, the appliance is said to be again coming into use on freight vessels, equipped with a full set of sails and moderate engine power.

A METHOD OF MULTIPLE WIRELESS TELEGRAPHY has been perfected by Professor Slaby, of Berlin, who recently exhibited his apparatus to the German Emperor and his suite. The method employed is simple tuning. On the above occasion Professor Slaby signalled to two stations, one at Schönweide on the upper Spree, 8 miles distant, and the other in his laboratory in the Charlottenburg Technical Institute, 2½ miles distant. Messages were received simultaneously from these two stations. The air wire for both sets of receiving apparatus was the lightning conductor on a near-by chimney, which was used without breaking its earth connection. Professor Slaby also exhibited a piece of apparatus which he called a multiplier. This is a resonator, the action of which may be explained by analogy with a tuning fork, which emits only a weak note until it is placed on a suitable sounding board. The resonator increases the potential of the received wave, and renders it easier to detect on the receiving apparatus.



Circles 100' apart.

PROPOSED RULING FOR RIGHT-HAND PAGE OF STADIA FIELD-BOOK.
(Circles and radial lines to be printed in light blue.)

THE WORLD'S SUGAR CROP OF 1900, says the Treasury Bureau of Statistics, amounted to 5,950,000 tons of beet sugar and 2,850,000 tons of cane sugar; that is, more than two-thirds of the sugar now produced is manufactured from beets. The rapid growth in the production of sugar from beets is shown by the fact that in 1840 beets supplied less than 5% of the world's sugar consumption; in 1850 this was 14%; in 1870, 34%, and in 1900, 67.71%. In 1840 the total sugar consumption in the world was only 1,150,000 tons, as compared with 5,702,000 tons in 1890, and 8,800,000 tons in 1900. In the year ending Sept. 1, 1900, Germany produced 1,950,000 tons of beet sugar, and France and Austria-Hungary each over one million tons; Russia made 880,000 tons, and Belgium and Holland, 340,000 and 170,000 tons respectively. Out of the total world's product of beet sugar "other countries"—including the United States—only aggregated 400,000 tons. Java exported the largest crop of cane sugar, or 670,000 tons; and Cuba comes next with 500,000 tons; Louisiana made 340,000 tons, and Hawaii 230,000 tons.

NOTES FROM THE ENGINEERING SCHOOLS.

PURDUE UNIVERSITY.—Two important changes have been made in the work of the senior year in the Department of Mechanical Engineering. The first is the offer of an elective course in car and locomotive design in connection with steam engine and general machine design. The second change consists in the addition of a new line of electrical work, which is intended to give mechanical engineering students a limited amount of training with reference to generators, motors and electric lines.

UNIVERSITY OF MICHIGAN.—Prof. Sadler of the Department of Naval Architecture and Marine Engineering, has taken steps to secure the erection at the University of a large model tank for testing models of ships. The only tank at present in existence in this country is the one at Washington, belonging to the Navy Department.

In the debate, held on April 5, with the University of Chicago on the subject "The United States Should Subsidize Her Merchant Marine," the representatives of the University of Michigan won, supporting the affirmative.

SYRACUSE UNIVERSITY.—Through the generosity of Mr. Lyman Cornelius Smith, the manufacturer of the Smith Premier typewriter, a College of Applied Science is to be opened this year at Syracuse. A building is now being erected on the campus to accommodate the Department of Mechanical Engineering. It is 133 by 56 ft., with five floors and a basement, and a drafting room in the lantern roof. Rooms are provided for testing machines, shops, laboratories, lecture and reception rooms, departmental library, museum, etc. Among the courses offered in Mechanical Engineering are Principles of Mechanism, Carpentry, Wood Turning, and Pattern Making, Forging, Filing, etc. Machine Tool Work, Steam Engine and Thermodynamics, Machine Design, Metallurgy of Iron, etc. Twenty-two courses are to be given in Civil Engineering and ten in Electrical Engineering.

UNIVERSITY OF MINNESOTA.—The Legislature has appropriated $60,000 for the College of Engineering. Most of the money will be used in making additions to the electrical laboratory and the lighting plant.

REPORT ON THE PROPOSED BARGE CANAL FROM THE HUDSON TO THE GREAT LAKES.

The complete report of the surveys for a barge canal across the State of New York, made last year, under the direction of State Engineer Edward A. Bond, has just been issued. An abstract of the report, from advance proofs, was printed on page 203 of our issue of March 21. The complete report forms a volume of over 1,000 pages and is accompanied by a portfolio containing 34 large maps, on which a large part of the data collected by the engineers is exhibited in detail.

As noted on the editorial page of this issue, the project for the construction of this barge canal is dead, for the present at least; and the hope for its resurrection is not bright. The record of these surveys, nevertheless, is of much interest to engineers. With the exception of the surveys conducted by the United States Deep Waterway Commission over much the same region, these surveys by the State of New York form the most elaborate and extensive survey for canal construction ever made in the United States.

The fact is not without value as evidence of the professional standard by which this work has been conducted, that while the legislature appro-

priated $200,000 for making these surveys, the entire work was completed at a cost of less than $150,000.

The entire report should have a place in the library of every engineering society and engineering school, and will naturally be desired by very many engineers to add to their private libraries. Applications for copies should be addressed to the office of the State Engineer, Albany, N. Y.

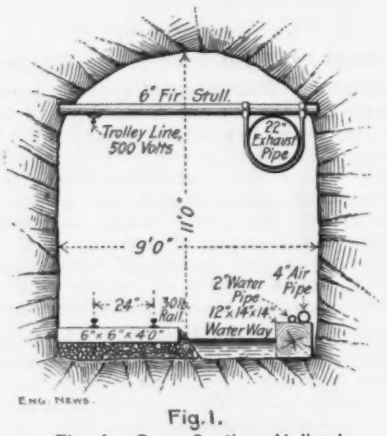


Fig. 1. Cross-Section, Unlined.

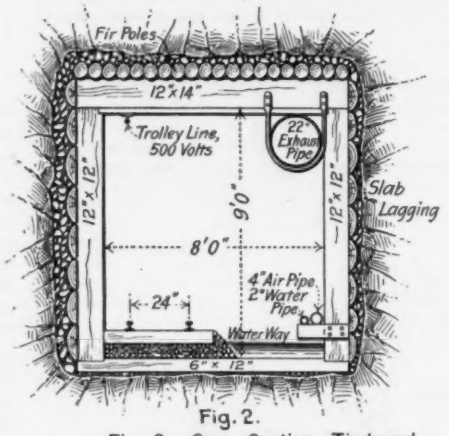


Fig. 2. Cross-Section, Timbered.

FIGS. 1 AND 2. TYPICAL SECTIONS OF KELLOGG TUNNEL.

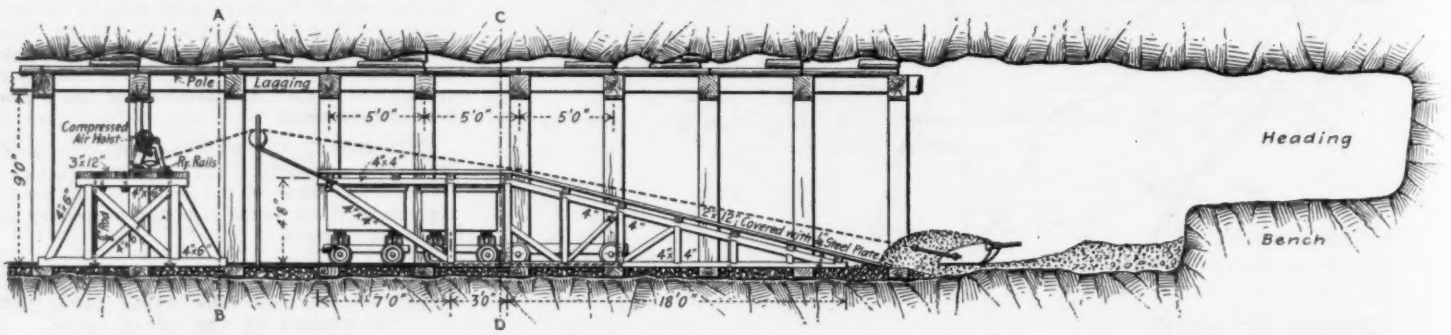
THE KELLOGG TUNNEL; BUNKER HILL & SULLIVAN MINES, IDAHO.

By Ulysses B. Hough.*

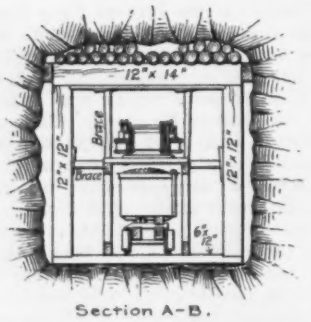
The tunnel known as the Kellogg Tunnel is situated at Kellogg, Shoshone County, Idaho, and is being driven by the Bunker Hill & Sullivan Mining & Concentrating Co., for the purpose of developing a group of mines worked by them and known as the Bunker Hill & Sullivan mines.

The mines up to the present have been worked through tunnels upon the property; but as the ore on these levels and above is fast becoming exhausted, the necessity of hoisting and pumping, or driving a tunnel at some lower level, became necessary. The mill of the company is situated some 9,000 ft. from the mines, and at an elevation of 800 ft. below the lowest working level, the ore being conveyed to the mill by a Bleichert aerial tramway. It was therefore decided to drive a tunnel from the mill to the mine, thereby furnishing an outlet for the ore and drainage for the water, besides giving some 750 ft. of stoping ground. The tunnel was commenced several years ago, but no great amount of progress was made, on account of various labor troubles in the Coeur d'Alene district, until the fall of 1897, when work was commenced with power drills, and has been continued almost constantly ever since, with three eight-hour shifts every day.

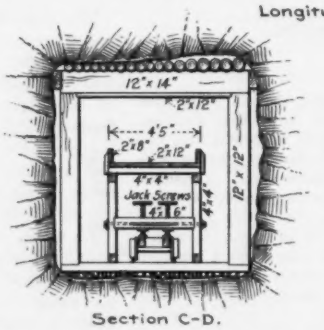
The entire length of the tunnel will be some 9,000 ft. when completed, of which 8,400 ft. is now finished and ready for use. A cross-section of the completed tunnel is shown in Fig. 1, and Fig. 2 shows the completed timbered section.



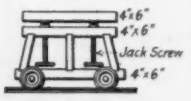
Longitudinal Section.



Section A-B.



Section C-D.



Car for Moving Hoist.

FIG. 3. LONGITUDINAL AND CROSS SECTIONS OF KELLOGG TUNNEL, SHOWING APPARATUS FOR LOADING MUCK INTO DUMP CARS.

From the very outset the aim has been to make the greatest possible progress. The first difficulty encountered was the removal of waste material after blasting. Shoveling by the day and under contract was tried with but little difference in results. A single-drum, double-cylinder Bacon hoisting engine was installed, mounted upon a wooden frame, so that loaded cars holding 1 cu. yd. of waste could pass under. A second wooden frame, with incline floor, was used just in front of the hoist. This frame was so arranged that two of the dump cars could be pushed under the end of it at the same time. A No. 1 scraper, or slusher, loaded with muck or waste, was hauled up this incline floor by the Bacon hoist, to an opening in the frame over the car, when the scraper load was dumped into the car and the scraper returned for another load. Two scraper loads usually filled a 1-yd. car, and never more than three were required. When the first car was loaded, it was pulled forward and the second car brought under the loading opening. When both cars were loaded, they were together pushed to a position on the track some 50 to 100 ft. below, where the trains were made up, and two more empty cars from the siding were brought to be loaded. A section of the hoist frame and mucker frame is shown in Fig. 3. Sufficient powder is used to break the rock, which is a quartzite, to a suitable size to be handled by the scraper.

Five men are employed at the removal of waste—one to operate the hoist, one to attend the dump cars, placing and removing, and three loading and attending the scraper. The time required to move 40 to 50 cu. yds. of waste is two to two and a-half hours.

When it becomes necessary to advance the incline floor, or mucker, a car underneath the frame carrying four jack screws, made from wornout machine-drill feed-screws, is used. The framework is jacked up until the entire weight is upon the car. The frame is then pushed back to allow the placing of new track. When the new rails are laid, the frame is advanced nearer the face of the tunnel, lowered to the floor, and is again ready for use. To move the hoist, a framework mounted upon a car truck is run under it, and four jack screws, made from wornout machine feed-screws, are used to jack the entire hoist and frame from the floor, when it is ready to move forward. The time consumed in moving both hoist and mucker will not exceed 20 minutes for the five men. These frames stand the work well. Both the present hoist frame and the mucker have been in use for 15 months and have been used to drive 3,400 ft. of tunnel. Both appear to be in fair condition.

The drills used are the No. 4-A Rand air drill, and have done excellent work. Two machines are used at a time, both working upon the same bar. They are driven by compressed air at 90 lbs. pressure, supplied through a 4-in. pipe from the air compressor supplying the mine. In untimbered ground, a heading is driven 10 to 20 ft. in advance, three rounds being shot in the heading to two in the bench.

All material and waste is handled to and from the tunnel by a General Electric motor, of four tons weight, running upon a track of 24-in. gage. This motor hauls a train of 15 loaded cars on an average, though as much as 20 cars are sometimes handled. The tunnel has a grade of 0.5% for the first half, and 0.3% for the remainder. Rails of 30 lbs. to the yard are being used. The track is single aside from the 200 ft. of siding near the face, which is moved from time to time as the tunnel advances.

The smoke and gases are removed through a 22-in. galvanized iron pipe, made of No. 18 iron, by a No. 9 Sturtevant exhaust fan. This fan, in 15 or 20 minutes, will remove all smoke and gas after blasting, to enable the men to return to work; and though the pipe is now over 8,000 ft. long, the time required to remove the smoke seems no longer than at first. This pipe is made in 18-ft. lengths, and all seams are riveted and soldered. Where the lengths join, heavy sheeting is wrapped around the joint and painted with coal tar, so there is little or no leakage along the line. The fan is driven by a 24-in. Pelton water motor, working under a head of 300 ft. An auxiliary air engine is always in readiness in case of any accident to the water motor.

The progress of the tunnel has varied much on

*Engineer Bunker Hill & Sullivan Mining Co., Kellogg, Idaho.

account of the variations in the ground encountered. In the month of October, 1898, an advance of 354 ft. was made, being the most progress made in any one month. In February, 1899, an advance of only 53 ft. was made for the month. In this month a considerable volume of water was encountered with running ground, and little or no progess was made for a week at a time. The average progress to the present has been 7.5 ft. per day. It has been found necessary to timber about one-third of the tunnel.

On the completion of the tunnel and its connection with the mine, ore will be hauled to the mill by electric motors. From 800 to 1,000 tons will be handled through the tunnel daily to supply the concentrator.

A KENTUCKY NATURAL BRIDGE.

The accompanying engraving, from a photograph forwarded to us by Mr. Cabell Breckinridge, C. E., of Danville, Ky., shows an interesting example of a so-called natural bridge. This "bridge" is situated in Whitley County, Kentucky, about four miles west of the Cincinnati Southern R. R. Geologically, it represents the upper part of the lower coal measure of this section. The

View of Natural Bridge in Whitley County, Kentucky; Span, 37 ft., Rise, 10 ft.

opening has a span of about 37 ft., and the height, from spring to crown, is 10 ft.; the thickness of the arch at the crown is about 9 ins. As is shown in the illustration, several trees are growing upon the arch.

PAGE BASCULE BRIDGE OVER THE CHICAGO RIVER AT ASHLAND AVE.

(With two-page plate.)

The great extent to which the bascule type of drawbridge is to be adopted at Chicago, Ill., in connection with the improvement of the Chicago River, has been discussed at some length in our issues of Jan. 10 and 31, 1901. All the bascule bridges already built over that river are on the Scherzer rolling-lift system (Eng. News, March 15, 1900), but several of the new bridges are on the fixed-center system, and one of these (at Clybourn Place) was described and illustrated in detail in our issue of Jan. 31, 1901. For the Ashland Ave. bridge, another style of fixed-center bascule has been adopted, the special features of which are in the operating mechanism and the counterbalance system. This design was invented and patented by Mr. John W. Page, who was formerly in the engineering department of the Chicago Sanitary District, and is now a member of the contracting firm of Page & Shnable, of Chicago.

Two designs for bridges on the Page system are described in this article. Both of these have through trusses, but while the first design (as adopted for Ashland Ave.) has deep trusses with overhead bracing, the second has shallow half-through trusses with curved bottom chords. This latter design has some points of advantage over the other, and it is certainly preferable from an aesthethic point of view, as it would seem almost impossible to give any artistic beauty to deep through trusses with ponderous heels and (in the Page bridge) exposed counterweights and operating machinery. In foreign practice, this bald and unsightly appearance would probably be avoided by the use of handsome masonry towers on the approaches, but the city of Chicago, with all its boasted civilization, has not reached a stage where a design involving such treatment would be seriously considered for a moment. The city will build its bridges as cheaply as possible, in fact it is a difficult problem to raise the money to build them at all, and if they are ugly, so much the worse.

One great advantage which the Page design is claimed to possess over any other design submitted to the Sanitary District, particularly for the Chicago River, is the width of clear waterway. For a distance of 200 ft. between dock lines, this width is said to be 20% greater than in other designs, and with a wider distance this percentage would increase proportionately. Another advantage is that no part of the superstructure comes below the water line when the bridge is open. This applies to the low as well as to the high truss design. For the high-truss design, the counterweight is about equally divided between the tail end of the trusses and the hinged inclined back struts. The proportion of these to each other fixes the direction of a curve for the rack and track by which the back strut bears upon the top chord, the bridge being theoretically balanced in any position. In the low-truss design, the shore span is hinged and acts the same as the back strut for the high-truss design, the counterweight being placed entirely on this span. In the design shown, the floor is of buckle plates and concrete with brick pavement, the weight of which reduces the amount of cast iron required. In this low-truss design, there is no difficult or complicated shop work, and it is claimed that no other design of bascule bridge will compare with the Page design in this respect.

The plans of these bridges were worked out by Mr. W. M. Hughes, M. Am. Soc. C. E., consulting engineer, Chicago. For plans and particulars of the bridges we are indebted to Mr. Page and Mr. Hughes.

HIGH-TRUSS DESIGN (ASHLAND AVE. BRIDGE).

The plans adopted for the Ashland Ave. bridge are for a high-truss structure on the Page design, as already noted, and the general design is shown in Fig. 1. The contracts for this bridge have been awarded by the Sanitary District at the following prices: Substructure, Page & Shnable, $35,542; superstructure, Massillon Bridge Co., $91,200; total, $126,742. We are informed that an analysis of the bids on this and other designs for a bascule bridge show that the Page design is economical in material and in cost.

SUBSTRUCTURE.—This will consist of four pedestal piers and abutments, all of concrete masonry. The abutments are 64 ft. 3 ins. long. The two pedestal piers on each side of the channel are 6 × 11 ft. on top, 40 ft. 3 ins. c. to c. The design of the superstructure is such that no part descends below the water line. Consequently, no pockets or chambers have to be provided in the substructure to receive the heels of the trusses when the bridge is raised, and the entire space between the abutment and piers on each side is available for waterway. The piers are enclosed by timber protection works, as shown. The bridge crosses the river at an angle of 83° between the center line of the river and bridge. The estimated quantities for the substructure are as follows:

Excavation	6,500 cu. yds.
Concrete	2,820 cu. yds.
Sheet piling and bracing	250,000 ft. B. M.
Timber in protection work and dock	23,500 ft. B. M.
Piles in protection work and dock	7,280 lin. ft.
Piles in cofferdam	2,100 lin. ft.

SUPERSTRUCTURE.—The bridge will have two leaves, 168 ft. c. to c. of bearings, each composed of two through trusses with plate girder floor beams. The trusses are 40 ft. 3 ins. apart, c. to c., carrying a 36-ft. clear roadway, with two 8-ft. clear sidewalks outside the trusses. The depth is 21 ft. c. to c. of chords at the outer end, and 28 ft. at the trunnion bearing, while a clear headway of 16 ft. is maintained between the floor and the portal bracing which is used at every panel point. Beyond the trunnion bearing, each truss has only a single triangular panel, composed of a vertical post, an inclined end post and a section of the top chord. Portal bracing of lattice trusses, with curved knee-brace connections, is provided at all panel points, and these trusses are connected by a longitudinal line of struts of similar trusses 2 ft. 8 ins. deep, midway between the main trusses, or on the center line of the bridge. Top lateral bracing is filled in between the portals, struts and main trusses. This is shown in Fig. 2.

The total weight of steel in each moving leaf is about 170 tons. The bridge is designed for the following loads: Live load; 100 lbs. per sq. ft. for the roadway, and 80 lbs. for the sidewalks; concentrated load, 20 tons on two axles 12 ft. c. to c. Wind pressure; 15 lbs. per sq. ft. on the movable part. The strains and composition of the members are shown in Fig. 3.

The floor system, Fig. 4, consists of 36-in. plate girder floor beams riveted between the truss posts, and having 13 plate girder stringers between them. These stringers are 15 ins. deep and rest upon angle iron brackets, while at the end floor beams they rest upon continuous shelf angles riveted to the webs of these beams. The floor consists of a course of long-leaf yellow pine timbers 3½ ins. thick, upon which is spiked the wearing surface of oak planks 2½ ins. thick. The street railway rails are of the form shown in our issue of Jan. 31, and are attached to the stringers in the same way. For the sidewalks, there are cantilever trusses 8 ft. 6⅞ ins. long, riveted to the truss posts. Upon these are three lines of 7-in. I-beams, while along the ends of the cantilevers is a 15-in. channel, having its top level with the top of the I-beams. Yellow pine stringers 3 × 6 ins. are laid on the channels and beams, to which the flooring of 2-in. long-leaf pine is spiked. To the face of the channel is bolted an oak guard stringer, with its outer face beveled to a V shape and fitted with an angle iron 4 × 4 ins. This is to protect the structure in case of vessels striking it.

The break in the roadway is about 2 ft. in front of the trunnions, and is faced by iron castings on which are cast-steel grooved floor plates. The floor plate on the moving span is 20 ins. wide and projects so as to cover the gap when the bridge is down.

The hand railing on the bridge is to be of iron, consisting of 3-in. gas pipe standards about 8 ft. apart, and connected by a top line of 3-in. and two lower lines of 2-in. gas pipe railing. This will certainly be neater and more sightly than the ordinary wooden railing, as designed for the Clybourn Place bridge. There will also be an iron ladder at each end, attached to the back strut and giving access to the overhead machinery.

TRUNNIONS.—The trunnion pins are hollow shafts of cast steel, 20 ins. diameter and 4 ft. 11 ins. long. Each has four keys. These pins are fitted to steel castings built into the main and approach trusses, as shown in Fig. 5.

COUNTERWEIGHTS.—At the upper end of the heel of each truss is a heavy rectangular counterbalance box, having two ½-in. web plates, to which cast-iron blocks will be bolted. This fixed counterweight will be equal to about half the amount required to balance the leaf. The remainder will be provided in the hinged back struts, whose heads rest on the top chords of the trusses, as already noted. About 620 tons of cast iron, or 310 tons for each leaf, will be required. Of this amount, about 155 tons will be in the trusses and 155 tons in the struts. The position of the moving weight shifts as the bridge opens or closes, as shown by the dotted lines in Fig. 1.

LOCKS.—The center locks are 5-in. steel pins, fitted between the webs of the lower chords of one leaf, and engaging with cast-steel sockets in the other leaf. These pins will be operated direct by air cylinders 8 × 12 ins., the stem of the pin forming the piston rod. When the bridge is lowered to position, further travel is prevented by a tail lock. This consists of a vertical 3-in. locking pin operated by an air cylinder 8 × 6 ins. placed at the head of the back strut and passing through a hole in the top chord of the truss. A 50-lb. spring is placed on top of the piston.

APPROACH SPANS.—The space between the abutment and the piers on each side will be spanned by riveted deck trusses, 45 ft. c. to c. of end bearings. The top outer corners of these have heavy steel castings and web plates to carry the 20-in. hollow axles or trunnions. Between the

posts of these trusses are plate girders carrying the I-beam floor stringers. Outside of the posts are riveted cantilever trusses for the sidewalks, with inclined struts to the feet of the posts. Top and bottom lateral bracing and vertical diagonal bracing is fitted between the trusses. The two operating houses will be located on these spans.

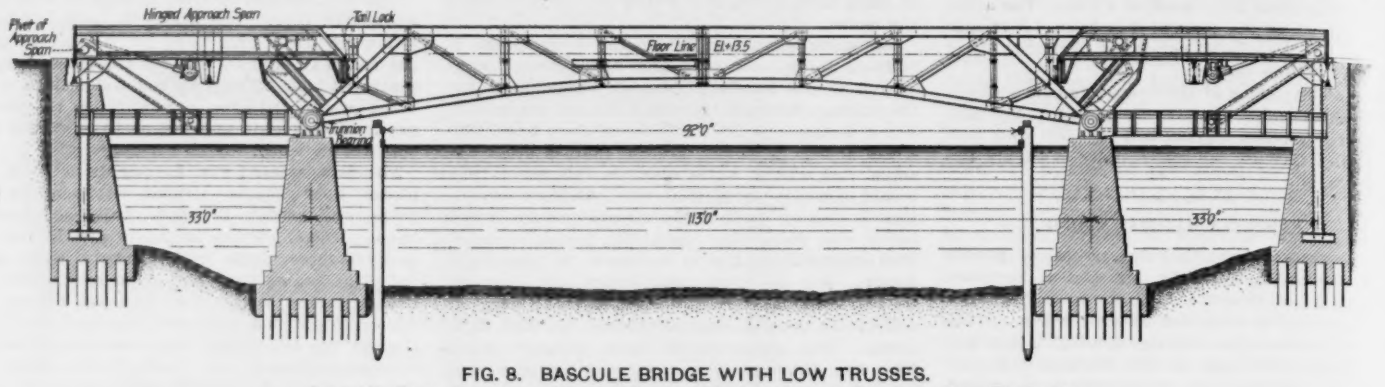


FIG. 8. BASCULE BRIDGE WITH LOW TRUSSES.
John W. Page, Inventor. W. M. Hughes, M. Am. Soc. C. E., Consulting Engineer.

They will be of frame construction, about 14 ft. 6 ins. long and 7 ft. 3 ins. wide.

OPERATING MACHINERY.—The arrangement of the operating machinery is decidedly novel, and is shown in Fig. 6. Behind each truss, and pivoted to the shore end of the approach girder, is an inclined back strut of H section, built up of two channels, with an I-beam between them. The heads of the two struts are connected by an overhead box girder, resting on two four-wheel trucks, which ride on the chords of the trusses. To the heads of the struts and the interior of the box girder are attached cast-iron counterweight blocks, secured in place by cement grouting, so that this pivoted back strut acts as a moving counterweight to the movable leaf.

On the rear end of the top chord of each truss is a curved track with roller plates and a rack. The radius of this track varies from 59 ft. to 229 ft., the profile of the track being formed to give a uniform turning moment due to the loading which tends to raise the bridge. The top chord of each truss at this part of the bridge has two web plates, each having two flange angles and a top plate, the latter forming a path for the strut rollers. Between the web plates are fitted the 5⅛-in. pins which form the teeth of the rack, the pitch of which is 11 3-16 ins. At each end of the transverse box girder between the back struts is a frame carrying two 7½-in. axles, each having two rollers or guide wheels 30 ins. diameter and 8 ins. wide on the face, with a 1½-in. flange on the inner side. The wheels of each pair are about 6 ins. apart, back to back of the flanges, and the treads run on the roller plates of the chord, as described, and shown in Fig. 7.

A 50-HP. electric motor is carried on the transverse box girder connecting the back struts, and is controlled by a band brake on the pinion shaft. The motor pinion A gears with a spur wheel B on a line shaft extending the full width of the bridge, and having at each end a pinion C. This gears with a spur wheel D on a shaft in the head of the strut. On this shaft is a pinion E, which in turn drives a pinion F, running loose on an axle and gearing with the rack of the truss. As the motor drives the train of gearing, the pinion acting on the rack draws the bridge up, while at the same time the head of the back strut descends, acting as a counterweight, its weight being carried by the rollers which run on the curved path on the top chords. Each leaf is thus operated by a 50-HP. motor, and the machinery is intended to

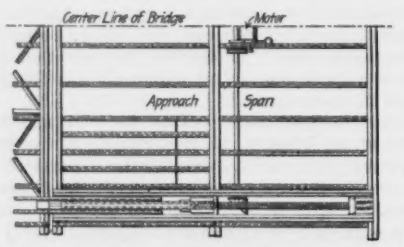


Fig. 8a. Part Plan Showing Operating Machinery.

open or close the bridge in one minute. The proportions of the train of gearing are as follows:

	Mark.	No. of teeth.	Pitch of teeth, ins.	Pitch diam., ins.	Width of face, ins.
Pinion	A	14	2¾	12¼	9
Spur wheel	B	68	2¾	59 19-32	9
Pinion	C	13	4	16 9-16	10½
Spur wheel	D	51	4	65 1-16	10½
Pinion	E	8	11 3-16	28½	7½
Pinion	F	8	11 3-16	28½	7½

LOW-TRUSS DESIGN.

As explained at the commencement of this article, designs have been prepared for a low-truss bridge, in which the approach spans form the moving counterweights. This design was not submitted for the Ashland Ave. bridge, but in Fig. 8 is shown the elevation of a bridge of this design, having a span of 113 ft. c. to c. of trunnions, with a clear waterway of 92 ft. The weight of steel in each leaf is about 94 tons.

The plate girder approach spans are 33 ft. long, pivoted to 14-in. pins over the abutments, and having at their outer ends segmental rockers and the concrete is finished off for a cement pavement. This makes a very heavy span, and any additional weight is provided by cast-iron blocks bolted between the I-beams.

OPERATING MACHINERY.—The arrangement of the operating machinery differs entirely from that of the high-truss bridge, and is shown in Figs. 8 and 9. Along each plate girder runs a screw 7½ ins. diameter over the thread, which is of square section, ¾ × ¾-in. A nut riding on this screw has trunnions, to which the forked end of a horizontal operating strut is fitted. The outer end of the strut is attached to the main truss. Under the approach span is an electric motor, driving a transverse shaft with two sets of bevel gear. Each set of gearing drives an inclined 6-in. shaft, whose upper end has a second set of bevel gearing by which the operating screw is revolved. The proportion of the bevel gears is as follows:

	No. of teeth.	Pitch of teeth, ins.	Width of face, ins.
Lower pair	22	2	5
Upper pair	19	2	5

As the main leaf rises, the approach span drops, acting as a moving counterweight. The bearings of these spans are braced by struts attached to double-web plate girders spanning the by-passes. With shorter approach spans, however, the struts might be carried down from the pins of the approach spans to the main trunnions, thus dispensing with the fixed plate girders. The radius of the rocker bearing and the form of the curved path in the truss may be varied to suit the requirements in each case. When the bridge is closed it is secured in position by tail locks and center locks. The tail lock has a toggle on the movable leaf, the ends of which seat against steel castings in the approach span, as shown in Fig. 9. This is operated directly by an air cylinder on the movable leaf. The center lock is similar to that of the high-truss bridge, as already described.

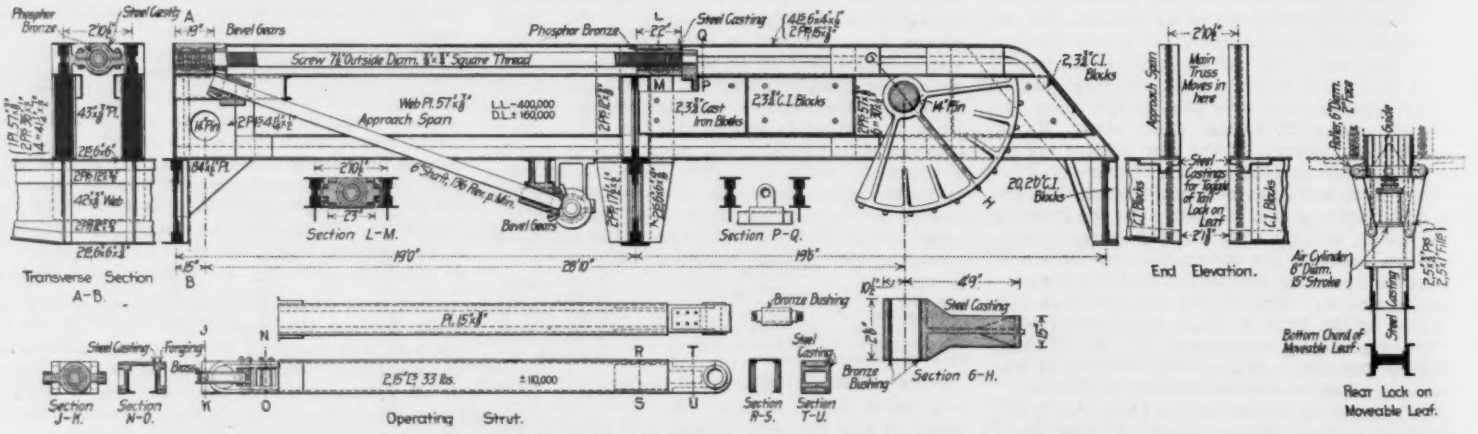


FIG. 9. OPERATING MACHINERY FOR LOW-TRUSS BASCULE BRIDGE.